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THE EXPLOSIVES ENGINEER

REG. U.S. PAT. OFF.

Forerunner of Progress in Mining, Quarrying, Construction

The Bureau of Mines has announced the winners in the National Safety Competition of 1950, and the records and other details of the contest are analyzed and discussed by Forrest T. Moyer, chief, Accident Analysis Branch, Health and Safety Division, U. S. Bureau of Mines, in an article beginning on page 71.

In reviewing the results, Mr. Moyer comments that the records of the 566 participating companies ranked with the best records since this annual competition was started in 1925. During a working time of approximately 146⅝ million man-hours, the injury-severity rate was 5.78 days lost per thousand man-hours. This was better than the previous best rate of 6.79 in the 1948 contest. The injury-frequency rate was 33.32 days lost per million man-hours, almost equaling the record rates in 1940 and 1949. Of the 566 companies enrolled, 172 reported no lost-time accidents during a total working time of 16⅝ million man-hours.

Each of the six winning companies—five mines and one quarry—is awarded a bronze Sentinels of Safety trophy donated by THE EXPLOSIVES ENGINEER, to be held for one year. Each employe of the six companies receives an individual Certificate of Achievement in Safety signed by the director of the U. S. Bureau of Mines. Also, THE EXPLOSIVES ENGINEER presents a green-and-white Sentinels of Safety flag to the victorious plants. The trophies, certificates, and flags will be presented formally to the winning organizations in appropriate ceremonies.

***

With production averaging more than 15,000 tons a day, the underground mining of limestone and its processing for industrial uses have contributed substantially to the growth and development of greater Kansas City, Missouri.

One of the newest and most modern of these limestone plants is owned and operated by Beyer Crushed Rock Company on a 551-acre tract of land 5 miles south of Kansas City. The room-and-pillar system is used to mine the mineral from a 12-ft.-thick stratum of hard and brittle Bethany limestone. Drill holes in the working faces are loaded with Hercomite* 5X, and blasts are fired with cap-and-fuse detonators.

A summary of the company's activities is presented by Farrell Castellani, on page 86.

***

An unusual use of explosives is the employment of military pyrotechnics by United Nations troops in Korea. Their use has been credited, in part, with the U. N.'s low casualty rate in comparison with the Communist foe.

Every combat branch of the United States military and naval establishment enters into this "Flash Gordon" picture. Pyrotechnics go into battle with infantry, tanks, artillery, air and naval forces. They are shot from guns, mortars, rockets, bazookas, or tossed by hand. So great an advantage has been gained by these new weapons that some military experts estimate that one U. N. soldier is equal to four of the foe.

These amazing arms, the product of the scientific age in which we live, exist for every war purpose: casualty, incendiary, deception, screening, signal, protection, rescue, and training. Behind their conception are the combined talents of chemists, physicists, engineers, and tacticians.

The Korean War has been an experimental field for new weapons and the improvement of old ones. Although they may not be publicized, it may be said that Uncle Sam's arsenal is developing still more effective "fireworks" should future occasion demand their going into battle.

For a review of these spectacular military pyrotechnics, by Mel Wharton, please turn to page 89.

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EDITORIAL STAFF: JOSEPH I. HORTY, *Managing Editor*; ELIZABETH M. JOYCE, *Assistant Editor*; GERTRUDE A. DONNELLY, *Assistant Editor*; EDWARD L. GRANT, *Art Editor*; FRANK J. CANOVA, *Production Manager*; CHARLES E. RABENOLD, *Advertising Manager*; THEODORE MARVIN, *Director*; MONTGOMERY R. BUDD, *Associate Director*.

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BLAST hole preparation costs reduced as much as 50 percent — that's the record progressive mine and quarry engineers are making with big-hole 42-T blast hole drills. Here's why:

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Because powder can be concentrated in larger holes, the blast breaks up material as well or better than with small hole charges —with no increase in explosive per ton of material blasted. With less oversize, secondary blasting is reduced.

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Because of their greater weight and size, large-diameter bits are less likely to stick or be thrown out of line by cracks or fissures. Also, with a big 12-inch hole there is no waste of time and powder due to springing — no "lost" holes.

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Bucyrus-Erie modern 42-T rigs, swinging as much as 6000 lb. of tools, drill big-diameter holes just as fast as smaller outfits drill small-diameter holes. From every angle, the 42-T's big holes save time, labor and cost.

Find out how fast-working Bucyrus-Erie blast hole drills can cut your preparation costs. Write for information on our complete line—42-T for 9 to 12-in. holes; 29-T for 6 to 9-in. holes; 27-T for 6 to 6⅞-in. holes; 22-T for 5⅛ to 6⅛-in. holes.

41B51C

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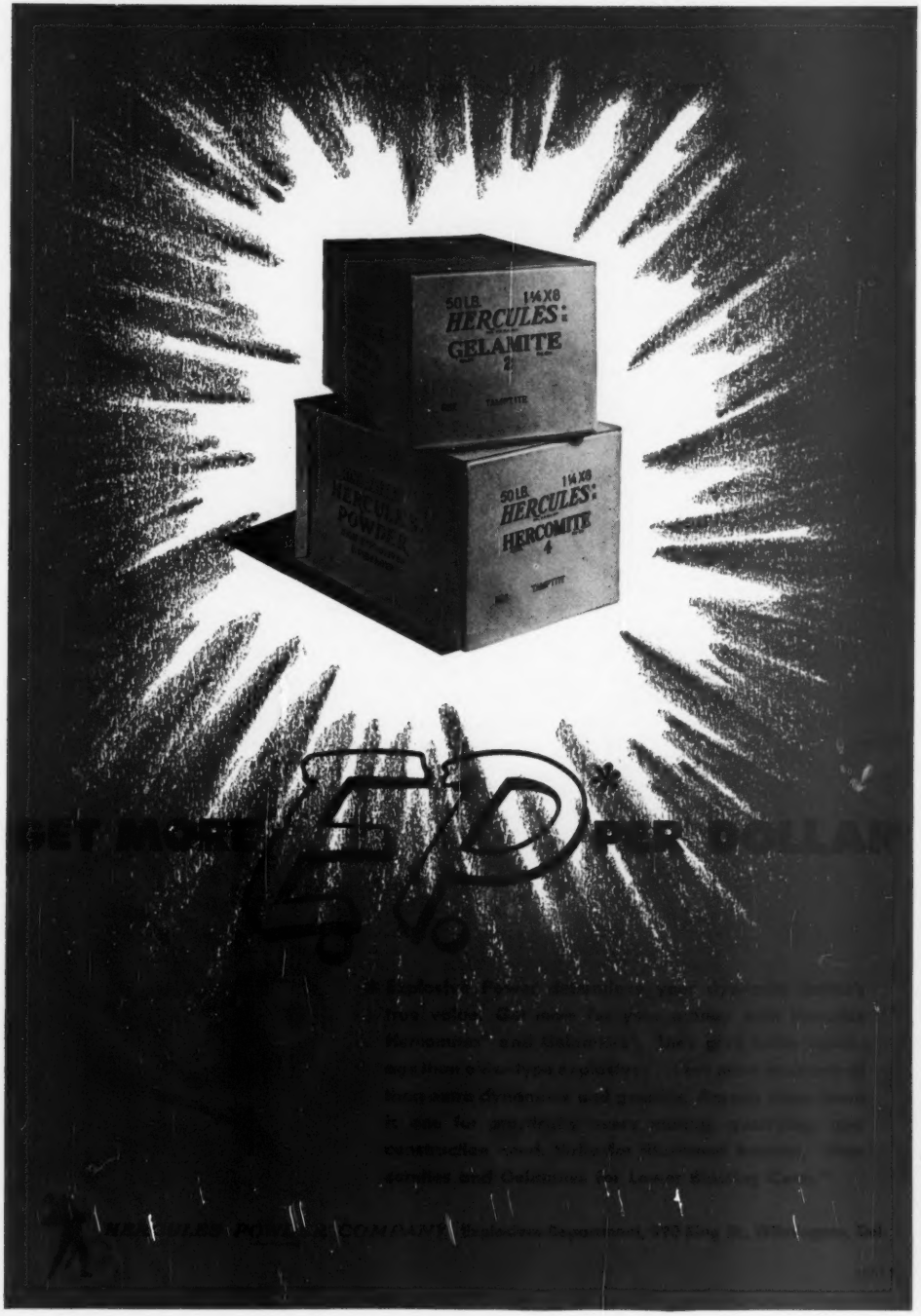

50 LB. 1¼X8
HERCULES
GELAMITE
2
50 LB. 1¼X8
HERCULES
HERCOMITE
4

Edward George Fox

PRESIDENT

THE PHILADELPHIA AND READING

COAL AND IRON COMPANY

A Biography

WHEN EDWARD GEORGE FOX was made executive vice president of The Philadelphia and Reading Coal and Iron Company on April 1 of this year, one of the newspapers in the anthracite district referred to him as "a man who knows mining thoroughly, who can talk the language of the miners working at the face of the coal seams, and who is always on deck when emergencies arise in the production fields." Today American industry requires that administrative leadership be supplemented by executive ability obtained through a working knowledge of operations and employe relations. Mr. Fox's capacity to fill this complex role prompted another local paper to comment: "When a company puts its future in the hands of men such as he who came up through the ranks . . . there is no need to worry about its future."

These comments sum up the reasons why Edward George Fox was recently elected to the presidency of the P. and R. company.

Ed, as he is known to his friends and associates, was born December 27, 1900, in Pottsville, Pennsylvania, the son of Jacob W. and Jennie M. (Kennedy) Fox. After finishing the grammar grades and two years at Pottsville High School, he completed his college-preparatory studies at Mercersburg Academy. He attended Pennsylvania State College, graduating in 1924 with a Bachelor of Science degree in mining engineering. In 1925, he received the degree of Engineer of Mining from Penn State.

Ed began his association with the anthracite industry during the summer vacation months of 1921, as an employe of the engineering corps of the Saint Clair and Minersville divisions of The Philadelphia and Reading Coal and Iron Company. He continued this program of working during vacation periods until his graduation from Penn State when he took his first full-time job as an engineer with J. G. White Corporation, a nationally known engineering-construction firm. After one year with the White organization, he went to work in the engineering department of The Hudson Coal Company.

In July, 1926, Ed joined Madeira Hill and Company as assistant to the superintendent at the Natalie colliery. He continued his association with Madeira Hill during the next eleven years, serving successively as assistant mine foreman at Greenough colliery, general inside foreman at Natalie colliery, assistant superintendent and superintendent at both Greenough and Natalie collieries. In 1936, he was made general manager of the company.

From 1932 to 1935, Mr. Fox taught subjects pertaining to mines and mining practices in evening extension schools of Pennsylvania State College at Mt. Carmel, Shenandoah, and Shamokin.

In 1937, he left Madeira Hill Company to become general manager of Colonial Collieries Company. Five years later, in March, 1943, he accepted an offer from Phoenix Contracting Company to return to the construction field as the company's general manager. Later, he became its president.

When, in March, 1946, The Philadelphia and Reading Coal and Iron Company organized a subsidiary unit, the Shen-Penn Production Company, to carry on comprehensive strip-mining operations at Shenandoah, Ed Fox accepted P. and R.'s invitation to become president of the new subsidiary. He left this post on November 1, 1947, to become general manager of the parent company. On April 1, 1951, he was elected to the post of executive vice president of The Philadelphia and Reading Coal and Iron Company and, a few weeks later, became its president.

Edward George Fox married Eleanor R. Jones on November 21, 1926, in Frackville, Pennsylvania. They have two children: Marcia (Mrs. Richard B. Ryon) and Edward, Jr., a mining engineering student at Lafayette College. The family home is at Twelfth and Mahantongo Streets, Pottsville, Pennsylvania.

Mr. Fox is a member of the anthracite section of the American Institute of Mining and Metallurgical Engineers, Newcomen Society, Pottsville Club, Pottsville Lions Club, Chamber of Commerce, Schuylkill Country Club, and Phi Gamma Delta fraternity. He is a member of the boards of trustees of the Pottsville Children's Home, Pottsville's Y.M.C.A., and Y.W.C.A.

EDWARD GEORGE FOX

Editorial

National Safety Competition

On the opposite page, the winners of the National Safety Competition of 1950 are announced and the year's results are analyzed and discussed by Forrest T. Moyer, chief, Accident Analysis Branch, Health and Safety Division, United States Bureau of Mines. The editorial staff of THE EXPLOSIVES ENGINEER joins with Mr. Moyer in extending congratulations to the employes of the six winning companies, and to each man in the other plants enrolled for participating with thousands of fellow-workmen in a nationwide effort to foster accident prevention in the mineral industry.

The 566 companies that were entered in the 1950 competition attained the second best records since this annual contest was started in 1925, 26 years ago. During a working time that totaled approximately 146½ million man-hours, the overall experience revealed an injury-severity rate of 5.78 days lost per thousand man-hours. This was significantly better than the previous best rate of 6.79 in the 1948 contest. The injury-frequency rate of 33.32 days lost per million man-hours was only slightly less favorable than the 1940 and 1949 rates. Of the 566 participating companies, 172 achieved injury-free records, representing a total working time of 16½ million man-hours.

To the Winners

The winning company in each of six groups—anthracite underground mines, bituminous-coal underground mines, metal underground mines, nonmetallic underground mines, open-pit mines, and quarries—is awarded a bronze Sentinels of Safety trophy, donated by THE EXPLOSIVES ENGINEER, to be held for one year. Every employe of these six companies receives an individual Certificate of Achievement in Safety signed by the director of the United States Bureau of Mines. To supplement the trophies and the certificates, THE EXPLOSIVES ENGINEER presents a green-and-white Sentinels of Safety flag to each company winner. Public presentation ceremonies are held each year at the mines and quarries to welcome the trophies and flags to their places of honor for the coming year.

Join in the Crusade

Safety in the plant is essentially good business. Today, practically every progressive employer has someone on the executive staff who is responsible for safety in the plant. The appointment of such an expert is not enough; he must have the day-to-day support of top management in the maintenance of a continuing program of education and safeguards.

The mineral industry has become more and more alert to the increasingly important role of accident prevention in conserving manpower. This is particularly true in this period of increased production for our national defense effort. There is a greater realization that accidents can be eliminated, or at least greatly reduced, by taking positive action. (See graph of the 26-year injury record on page 74.) It is not luck that gains enviable results, but sincere determination plus the application of every available means to accident prevention—including the National Safety Competition.

We urge those who have not yet enrolled in this annual nationwide contest to communicate with the U. S. Bureau of Mines, Washington 25, D. C. Complete details for entrance will be gladly and promptly furnished.

Oil from Shale

In his annual report for 1950, Oscar L. Chapman, Secretary of the Interior, describes the progress made by the Bureau of Mines in an experimental program of mining and retorting oil shale, and refining the recovered oil, at a demonstration plant at Rifle, Colorado.

Well up the side of a steep cliff that rises above the Colorado river, a 500-ft. layer of oil shale outcrops. A 70-ft. segment of this deposit, known as the Mahogany Ledge, averages approximately 30 gals. of oil per ton of shale, while the remainder of the 500-ft. outcrop appears capable of producing about 15 gals. per ton. Exploration, which is far from complete, includes a number of core-drilling and channel samples from cliff outcrop, and indicates a reserve of more than 100 billion barrels of oil from the Mahogany Ledge and close to 500 billion barrels from the 500-ft. layer in a 1,000-sq. mi. area.

For several years the Bureau of Mines has been experimenting with drilling and blasting techniques and, on the basis of estimates made late in 1950, it believes that the oil shale at Rifle can be mined for a total cost of about forty-three cents a ton, with an output of about 3 tons of oil shale per pound of explosives.

The investigation of mining methods includes basic studies on the action of explosives in the shale, with determination of the strain developed in rock at various distances from the explosives. It may be expected that much useful and basic information to the mining industry will be developed during the Bureau's investigation.

Don'ts

Don't open kegs or cases of explosives in a magazine.

Don't use explosives that are obviously deteriorated.

Don't carry explosives in pockets of clothing.

Don't force cartridges of any explosives into a bore hole or past any obstructions in a bore hole.

Don't load a sprung bore hole with another charge of explosives until it has cooled sufficiently.

Don't tamp with metallic bars or tools. Use only a wooden stick with no exposed metal parts.

THE NATIONAL SAFETY COMPETITION OF 1950

Statistics show that mines and quarries enrolled in this nationwide contest have more favorable safety records than the average corresponding operations not enrolled

FORREST T. MOYER

Chief, Accident Analysis Branch, Health and Safety Division,
Bureau of Mines, U. S. Department of the Interior

THE SENTINELS OF SAFETY TROPHY

THE 566 mineral operations in the United States that participated in the 1950 National Safety Competition attained the second best records since this annual contest was started in 1925, 26 years ago. The overall experience, as measured by an injury-severity rate of 5.78 days lost per thousand man-hours, was more favorable than in any other year with the exception of 1949, when the rate was 5.56. The 1950 rate was significantly better than the next succeeding one of 6.79 in the 1948 competition. The frequency of occurrence of disabling injuries—33.32 days lost per million man-hours—was better than in any other of the 26 contest years, with the exception of 1940 and 1949, when the injury-frequency rate was slightly more favorable.

The records made in the 1950 competition clearly show the effectiveness of this contest as a means of promoting safety at plants where safety is aggressively and efficiently included in each day's work. Such competitions, conducted by the United States Bureau of Mines, serve a very useful purpose by arousing and holding the interest of employes and officials in accident-prevention work. Year after year, statistics show that the average mine or quarry enrolled in the contest had a more favorable safety record than the average mineral plant that was not entered in the contest.

National recognition is due the mineral plants that attained top safety honors in the six group classifications. For achieving the best record in each group, each of the six operations listed below is awarded a bronze Sentinels of Safety trophy and a Sentinels of Safety flag, donated by THE EXPLOSIVES ENGINEER magazine. In addition, each employe of the six winning plants will be awarded an individual Certificate of Achievement in Safety by the Bureau of Mines for his contribution to the plant's record.

The enrollment of 566 mineral operations in the 1950 contest was the second largest in the history of this annual nationwide competition (the record number was 646, in the 1949 contest). In 1950, the enrolled mines

THE WINNERS

ANTHRACITE
Birdseye Mine
The Hudson Coal Company
Throop, Pennsylvania

BITUMINOUS-COAL
Reliance No. 7 Mine
The Union Pacific Coal Company
Reliance, Wyoming

METAL
Tobin Mine
Republic Steel Corporation
Crystal Falls, Michigan

NONMETALLIC
Barberton Limestone Mine
Pittsburgh Plate Glass Company
Barberton, Ohio

OPEN-PIT
Embarrass Mine
Pickands Mather & Company
Biwabik, Minnesota

QUARRIES
Rogers City Quarry
Michigan Limestone & Chemical Company
Rogers City, Michigan

ANTHRACITE WINNERS: Some of the underground employes who helped Birdseye mine of The Hudson Coal Company win top safety honors in the 1950 competition.

SUPERVISORY PERSONNEL: Officials and inspectors of Birdseye mine, left to right: Henry H. Null, assistant superintendent; Karl T. Miller, safety engineer; William B. Roth, mine foreman in 1951; Joseph G. Houlihan, outside foreman; John Nealon, assistant outside foreman; James Bell, fire boss; Wesley I. Stonebraker, superintendent, Olyphant-Eddy Creek Collieries; Charles Kaczinski, safety director, District No. 1, U. M. W. of A.; Joseph Nixon, mine foreman in 1950; H. R. Wilson and W. J. Buswink, Federal mine inspectors; William Simpson, sectional foreman; George Robinson, machine mining department; Theodore Wackley, Pennsylvania State mine inspector.

and quarries were worked for a total of approximately 146¾ million man-hours. During this time of exposure to work hazards, there were 4,880 disabling injuries. Of this number, 90 were fatal and 4,790 were nonfatal lost-time injuries. The total time lost from all injuries was 846,158 days, with 540,000 days chargeable to fatal injuries and 306,158 days to nonfatal.

Of the six group classifications of plants, as designated in the rules of the contest, the open-pit group had both the lowest injury-severity and injury-frequency rates. The highest rates were in the anthracite group. It should be noted here that only injuries and man-hours of exposure in workings underground are considered in compiling the safety records of the anthracite mine group.

BIRDSEYE SLOPE PORTAL: A trip of mine cars loaded with Birdseye coal emerging from the portal of the slope.

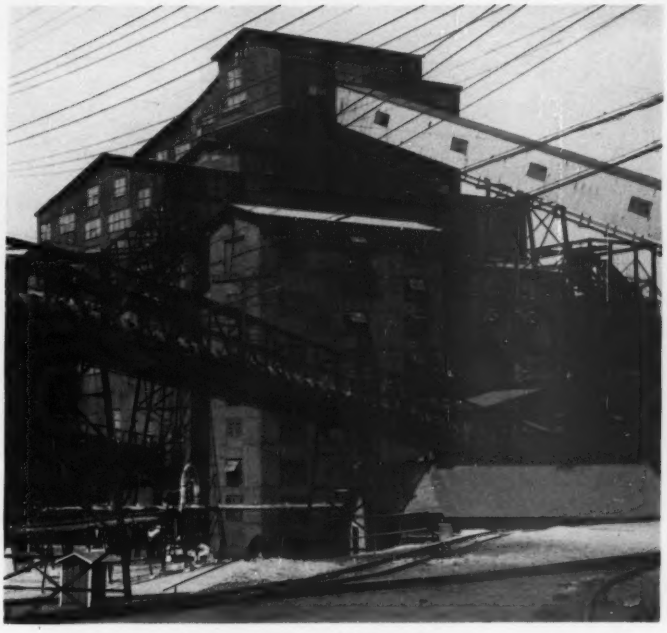
Perfect Safety Records

The attainment of a perfect safety record during a period of one year's operating time is definite proof of the extremely close cooperation of all employes in an effective safety program. In 1950, injury-free records were achieved by 172 mines and quarries. The aggregate worktime at these 172 plants was more than 16½ million man-hours. Such a record represents a magnificent example of what can be accomplished by persistent plugging of accident-prevention work. The operations that had injury-free records included 111 quarries, 26 open-pit mines, 16 nonmetallic underground mines, 9 bituminous-coal underground mines, 7 metal underground mines, and 3 anthracite underground mines. All of the men working at these injury-free operations are to be commended for their contributions

to the achievement of such outstanding accomplishments in safety.

Basis for the Awards

The National Safety Competition is a contest conducted annually by the U. S. Bureau of Mines. It is designed to aid in the promotion of accident-prevention work in mines and quarries located within the United States. Enrollment of companies in the competition is voluntary. The plants participating are grouped into six classifications: anthracite underground mines, bituminous-coal underground mines, metal underground mines, nonmetallic underground mines, open-pit mines, and quarries. The contestant in each group that has the lowest injury-severity rate (number of days lost through disabling injuries per 1,000 man-hours of work) is the winner, and is awarded a bronze Sentinels of Safety trophy, made available by THE EXPLOSIVES ENGINEER. If two or more plants in the same group have had accident-free records during the year, their standing in the contest is determined by the number of man-hours worked. A disabling injury is defined as one that incapacitates an employe for longer than the remainder of the day on which the accident occurred. In the competition, fatal, permanent total, permanent partial, and temporary injuries are taken into consideration in computing the severity rate of a plant.

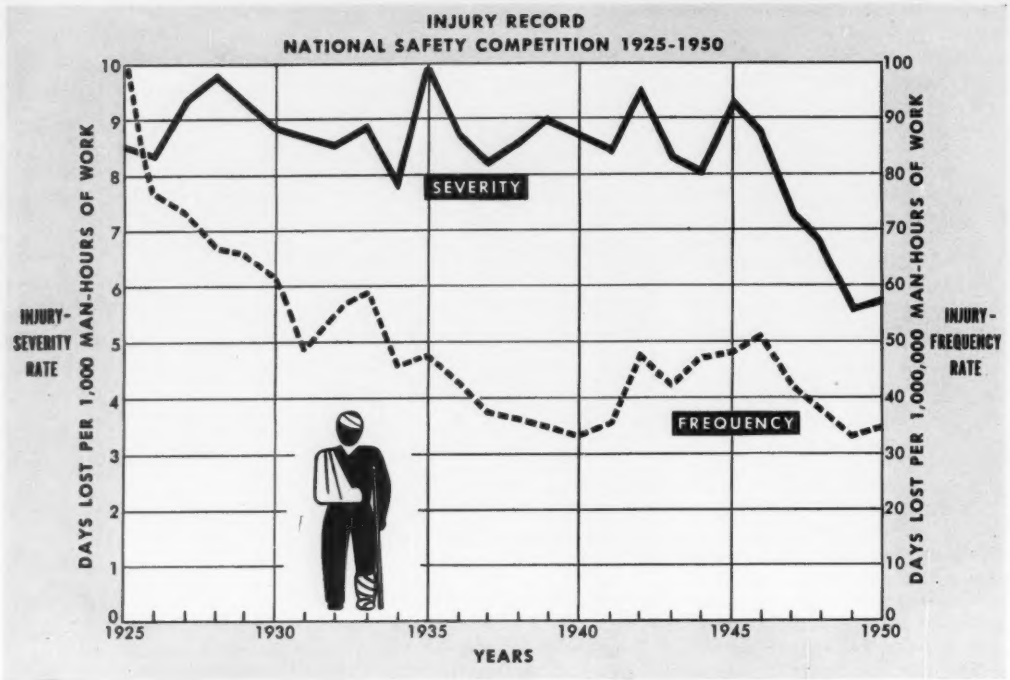


THE BREAKER: Coal from Birdseye mine is prepared for commercial uses in the Olyphant Colliery breaker, shown above.

The Awards

A bronze Sentinels of Safety trophy is awarded to the winning mine or quarry in each of the six groups, as a symbol of national recognition for outstanding leadership in safety in its operations. In addition, a Sentinels of Safety flag, also provided by THE EXPLOSIVES ENGINEER, made in the traditional colors of safety—green and white—is presented to each of the winning companies. The flag serves

RELIANCE NO. 7 MINERS: These Union Pacific Coal Company miners worked 449,090 man-hours underground in 1950, without a disabling injury.



SALIENT FEATURES OF THE NATIONAL SAFETY COMPETITION 1950

Type of Mine	*Number of Mines*	*Man-hours*	*Fatal Injuries*	*Nonfatal Injuries*	*Total of Injuries*	*Days of Disability*	*Frequency Rate*	*Severity Rate*
Anthracite	52	20,586,333	21	1,833	1,854	189,448	90.068	9.203
Bituminous-coal	138	58,474,895	48	1,608	1,656	446,466	28.320	7.635
Metal	50	16,267,061	9	474	483	82,873	29.692	5.095
Nonmetallic mineral	42	7,688,533	5	220	225	43,821	29.264	5.700
Total	282	103,016,822	83	4,135	4,218	762,608	40.945	7.403
Open-pit	73	23,590,083	2	320	322	39,038	13.650	1.655
Quarries	211	19,857,534	5	335	340	44,512	17.122	2.242
Grand Total	566	146,464,439	90	4,790	4,880	846,158	33.319	5.777

TWENTY-SIX-YEAR HISTORY OF THE NATIONAL SAFETY COMPETITION 1925-1950

Type of Mine	*Man-hours*	*Fatal Injuries*	*Nonfatal Injuries*	*Total of Injuries*	*Days of Disability*	*Frequency Rate*	*Severity Rate*
Anthracite	596,922,290	702	52,666	53,368	6,202,780	89.405	10.391
Bituminous-coal	1,151,448,548	1,253	54,815	56,068	11,836,311	48.693	10.279
Metal	441,296,727	354	15,688	16,042	3,120,477	36.352	7.071
Nonmetallic mineral	98,573,341	66	3,007	3,073	588,044	31.175	5.966
Total	2,288,240,906	2,375	126,176	128,551	21,747,612	56.179	9.504
Open-pit	239,356,277	79	4,257	4,336	753,371	18.115	3.147
Quarries	413,056,310	211	8,474	8,685	1,890,786	21.026	4.578
Grand Total	2,940,653,493	2,665	138,907	141,572	24,391,769	48.143	8.295

RELIANCE SUPERVISORS: Left to right, first row, Ronald Noble, John E. Sepich, Shandow Bacskay, Robert Hower, Frank Sepich, Lyman G. Welch, William L. Foster, Fred M. Bradley, Barton Grosso, Jr., all unit foremen. Second row, Laurie Kangas, shop foreman; Dan Bonuchi, master mechanic; Leo Kozola, night foreman; James Zelenka, unit foreman; Maurice Messersmith, mine foreman; James Hamilton, Mack Fresques, Ferrel Wilde, George Gutierrez, John Vidakovich, all unit foremen; William Matthews, assistant mine foreman. Third row, Thomas M. Stewart, Enoch Tynsky, Andrew J. Havrilo, Henry G. Wisniski, George T. Lightner, Wells Anderson, Frank Liska, Carl Sandstrom, all unit foremen; Lawrence H. Welsh, mine superintendent.

effectively as a daily reminder of what has been and what can be accomplished in safety. The employe-contribution to the record of each winning plant is recognized by the award of individual Certificates of Achievement in Safety by the Bureau of Mines to each workman and official. Certificates of Achievement in Safety are awarded to the next four ranking plants after the winner, as well as to those plants with no injuries during the year, provided 30,000 or more man-hours are worked.

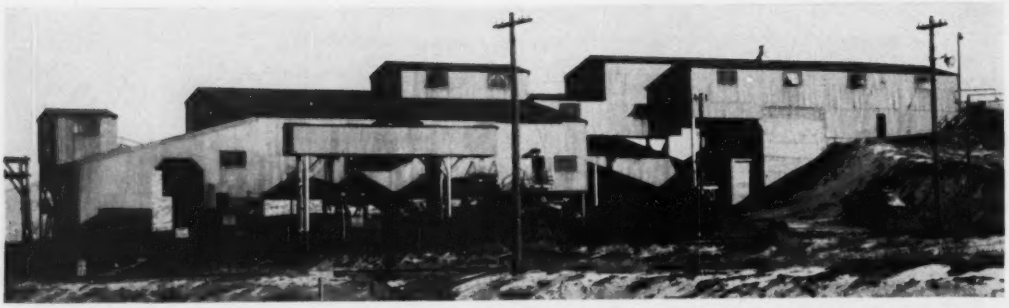
The official presentation of the six Sentinels of Safety trophies and flags, as well as the individual Certificates of Achievement in Safety, will be made at a time and place to be determined by each winning company, through arrangements made with the Bureau of Mines.

Anthracite Mines

Birdseye mine of The Hudson Coal Company at Throop, Lackawanna County, Pennsylvania, achieved top safety honors in the anthracite underground mines group. Its winning record in 1950 was an injury-severity rate of 0.167 day lost per 1,000 man-hours. The employes worked 113,738 man-hours underground with only 4 disabling injuries, which caused an aggregate time loss of 19 days. The award of the Sentinels of Safety trophy in the 1950 contest is the first time the Birdseye mine has won in its 16 years of participation in the National Safety Competition. Since its enrollment in 1935, the Birdseye mine has been awarded Certificates of Honorable Mention in the 1936, 1938, and 1940 competitions. Conspicuous improvement in accident prevention has been apparent at this mine since 1947, when a total of 35 disabling injuries was recorded. Since that time, this number has been halved each year. Such progressive improvements in its records clearly show what can be attained through the close cooperation of all employes and officials in an effective safety program.

In all, 52 anthracite underground mines participated in the 1950 competition, one more than in the 1949

PREPARING TO BLAST: The blasting crew completing loading details at a working place. Left to right, Fred Bradley, unit foreman; Dean Pyper, loading tamping material; Cecil Wathern, tamping a drill hole; John Allen, holding shot wires; Fred Larson, carrying supplies.



RELIANCE TIPPLE: An average production of 2,200 tons of high-volatile bituminous coal is processed each day in this modern tipple at Reliance No. 7 mine.

TOBIN MINERS: A crew of miners just before going to work on a shift at Republic's Tobin mine, Crystal Falls, Michigan.

TOBIN'S SUPERVISORS: Left to right, bottom row, E. C. Norris, Jr., superintendent, industrial relations; E. H. Anderson, superintendent; J. H. Torreano, mining engineer; L. I. Morton, W. T. Gullman, and G. S. Floodstrand, underground foremen; J. H. Meyer, chief chemist; J. R. Tregear, safety inspector. Top row, M. Jacka, mechanical foreman; E. A. Lindstrom, chief clerk; H. A. Berg, surface foreman; G. J. LaFreniere, electrical foreman. In the inset is Emil Johnson, mining captain.

contest. The injury experience at these mines was not as favorable as in 1949. During a total worktime of 20½ million man-hours in 1950, the injury-severity rate was 9.20 days lost per 1,000 man-hours, well above the corresponding rate in 1949. Also, the injury-frequency rate of 90.07 injuries per million man-hours of work in 1950 was less favorable than the 1949 rate.

Bituminous-Coal Mines

For the third successive year, Reliance No. 7 mine of The Union Pacific Coal Company at Reliance, Sweetwater County, Wyoming, was awarded the Sentinels of Safety trophy for having had the best safety record among the bituminous-coal mines enrolled in 1950. This mine was operated throughout last year without a disabling injury, during a worktime of 449,090 man-hours. This winning record marked the third straight year of injury-free operations at this property—a total of 1,219,728 man-hours without a single lost-time injury. Reliance No. 7 mine is the first bituminous-coal underground mine to win the trophy three years in succession, a truly outstanding safety accomplishment. Such records are made only through persistent efforts and hard work on the part of all employes and officials in carrying on a carefully conceived, well-directed campaign to eliminate accidents from daily work in the mine.

The award of the bronze trophy to Reliance No. 7 mine for 1950 was the twelfth time that such an award has been made to one of The Union Pacific Coal Company's mines. Other mines of the company that have won top

safety honors in former competitions were the B, C, D, Winton No. 1, Rock Springs No. 4, and Winton Nos. 1 and 7½ mines. The D mine also won the Sentinels of Safety trophy three times (1937, 1943, and 1944) but not in succession, as did Reliance No. 7 mine. The outstanding achievements in safety in the mines of this company through the years are definite proof of the wholehearted cooperation of all of the employes in well-planned safety programs.

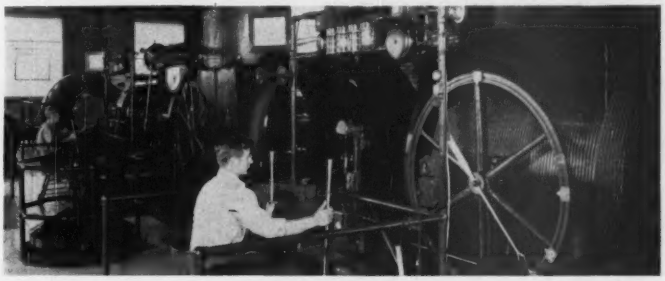
The enrollment in this group in 1950 was 138 mines, 21 fewer than in 1949. Although the injury-severity rate of 7.64 days lost per 1,000 hours for the participating mines in 1950 was less favorable than in 1949, it was the second lowest in the 26-year history of these annual contests. The injury-frequency rate of 28.32 per million man-hours represented an improvement over 1949. Also, it was well below the 26-year average rate of 48.69 for participating bituminous-coal underground mines.

Metal Mines

The Tobin iron-ore mine of Republic Steel Corporation at Crystal Falls, Iron County, Michigan, won the Sentinels of Safety trophy in the metal underground mines group. The winning record was a perfect one—no lost-time injuries in a worktime of 321,683 man-hours through 1950. This award of the trophy was the first to this mine. However, it received Certificates of Achievement in Safety in the 1939, 1940, 1945, and 1947 competitions, for outstanding safety accomplishments. In its 14-year history in the contests, the employes of Tobin mine have worked more than 4¼ million man-hours, recording a frequency rate of 11.67 injuries per million man-hours. Its 14-year record illustrates the importance of perseverance in accident-prevention work. The personnel of this mine has earned sincere congratulations for the perfect safety record in 1950, and for long and persistent efforts toward the attainment of this goal.

A total of 50 metal underground mines was enrolled in 1950. As a group, they recorded the best injury-severity rate of any year since the competition was started in 1925. The 1950 rate of 5.095 days lost per 1,000

SURFACE STRUCTURES: A view, looking northeast, of some of the surface structures at Tobin mine—the mine headframe, sheave stands, shop building, and office.



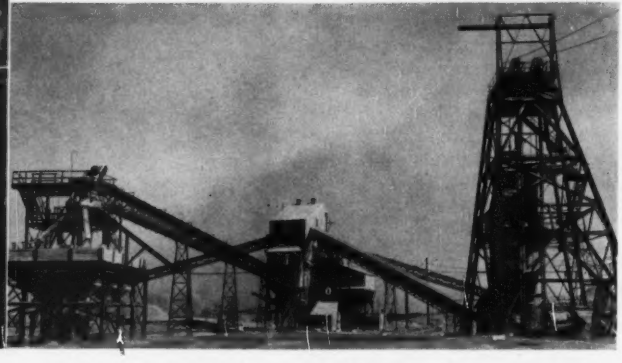
TOBIN'S ENGINE HOUSE: The skip and cage hoists being operated by Hoisting Engineers George A. Sorenson, left, and John Bosko.

EATING DOWN BELOW: Some of Barberton's miners in the underground lunchroom enjoying food and relaxation.

BARBERTON'S SUPERVISORS: Some of the supervisory personnel at Barberton mine of Pittsburgh Plate Glass Company.

ONE OF THE ENTRIES: A typical view of an entry in the Barberton mine, with rooms and pillars on each side.

DRILLING A ROUND: A crew operating four drills from a jumbo in a room face in the Barberton mine.



SURFACE STRUCTURES: No. 2 shaft headframe and the screening plant at Barberton mine.

OPEN-PIT EMPLOYES: Some of the employes at Embarrass mine who helped to achieve a record of 650,239 man-hours of work in 1950, without a lost-time injury.

man-hours was slightly below the former low rate of 5.282 attained in the 1930 contest. The frequency of 29.69 injuries per million man-hours represented a marked improvement over the corresponding rate in 1949. However, these mines were operated for approximately the same number of man-hours as in 1949, when 5 more mines were in the contest.

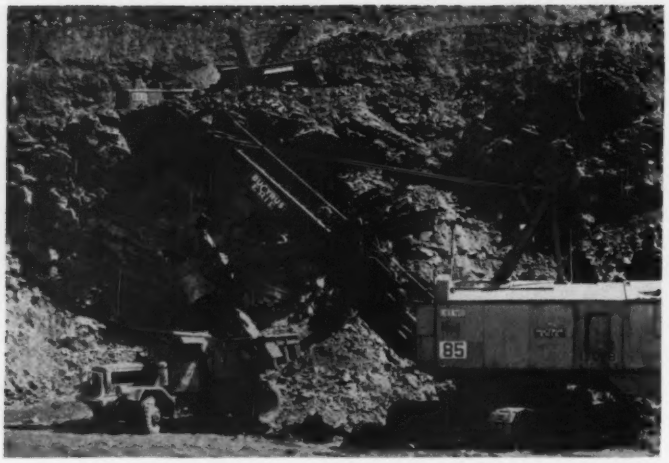
Nonmetallic Mines

The top award for the best safety record in the nonmetallic underground mines group goes to the Barberton limestone mine of Pittsburgh Plate Glass Company, at Barberton, Summit County, Ohio. In 1950, this mine was worked 402,775 man-hours without a disabling injury. During its three years of enrollment in the competition, the injury experience has been improved sharply. The records show a total of 8 disabling injuries in 1948, 1 such injury in 1949, and an injury-free record in 1950. Such splendid accomplishments are realized only by the constant, wholehearted cooperation of all employes in a concerted drive to work safely at all times.

The 42 nonmetallic underground mines participating in 1950 were operated for a total worktime of more than 7½ million man-hours. The increase in the rate of operating activity had an adverse effect on the group's safety record; both the injury-severity and injury-frequency rates were less favorable than in 1949. However, both rates were better in 1950 than the corresponding average rates for the 26-year history of the competition.

SAFETY COMMITTEE: Left to right, front row, Auno Hill, surface foreman; John Erickson, truck foreman; H. J. Anderson, master mechanic; R. F. Kohn, superintendent; Ignatz Miklausich, foreman, auto mechanics; Clyde Helmer, district safety inspector; Arvid Tuurie, welder. Back row, Bennie Constantine, truck driver; Eino Saari, auto mechanic; Edward Servatka, electrician; Floyd Enquist, foreman, auto mechanics; Waino Kauppi, blacksmith; Frank Pezdirc, carpenter; John J. Turk, foreman, auto mechanics.

PART OF THE PIT: Pointing his camera toward the east, the photographer took this picture to record some of the open-pit activities at Embarrass mine.



RECOVERING IRON ORE: Following a blast in a bank on one of the pit levels, a shovel operator loads out iron ore into one of the company trucks.

Open-Pit Mines

For the second successive year, the Embarrass open-pit mine of Pickands Mather & Company, at Biwabik, St. Louis County, Minnesota, was the winner of the Sentinels of Safety trophy for having had the best safety record among the open-pit mines enrolled in the competition. Its winning record in 1950 was a perfect one, with 650,259 man-hours of exposure without a lost-time injury. During its seven-year history in the contest, this iron-ore pit has been operated more than 4½ million man-hours, with an injury-severity rate of 1.85 days lost per 1,000 man-hours, and an injury-frequency of 2.38 per million man-hours. The award of the trophy in 1950 is a tribute to the men of this mine, in recognition of their two successive injury-free years and their persistent efforts to eliminate accidents in their daily work.

The open-pit mines of Pickands Mather & Company compiled remarkable safety records in the 1950 contest. In addition to its Embarrass mine winning the bronze trophy, the company's Mahoning mine attained second place and its Scranton mine fourth, all three with perfect records of no injuries during the year. Other injury-free mines of the company in this group were Sagamore, Corsica, Plymouth, and Volunteer.

The injury experience in 1950 at the 73 participating open-pit mines was one of the best in the competition's history. The injury-severity rate of 1.66 days lost per 1,000 hours of exposure was well below that of any other year except in 1931, when the rate was 0.50. The injury-frequency rate of 13.65 per million man-hours in 1950 was slightly less favorable than in the preceding year but was well below the 26-year average rate of 18.12 for this group.

ROGERS CITY QUARRY: Part of the 5-mile-long quarry face at Rogers City, Michigan. A 20-cu. yd. electric shovel operator is loading blasted limestone into 50-cu. yd. cars.

Quarries

An old-timer in the National Safety Competition, the Rogers City quarry of Michigan Limestone & Chemical Company, at Rogers City, Presque Isle County, Michigan, won top honors in the quarry group and is awarded the Sentinels of Safety trophy. Its winning record in 1950 showed the amazing total of 1,273,376 man-hours of work with no disabling injuries. This limestone quarry, the largest operation of its kind in the country, also won the trophy in four other years—1929, 1932, 1933, and 1934. In its 23-year history in the competition, the Rogers City quarry employes have worked a total of more than 21½ million man-hours, during which 34 disabling injuries occurred at a frequency rate of 1.57 per million man-hours. This long-time record offers conclusive evidence that unceasing hard work and the full cooperation of all employes in effective safety programs pay big dividends in the reduction and elimination of injuries in mineral operations. The men of this quarry are deserving of the highest praise for this remarkable record.

As a group, the 211 quarries enrolled in the 1950 contest had favorable safety records. The injury-severity rate of 2.24 days lost per 1,000 man-hours was the second best annual rate in the 26 years of the contest. The injury-severity rate was more favorable only in 1946, when the corresponding rate was 1.96. Although the injury-frequency of 17.12 per million man-hours

ROGERS CITY PLANT: The plant at Rogers City with Lake Huron in the background. Plant capacity is 4,000 gross tons per operating hour.

in 1950 was not among the lowest annual rates for the group, it was well below the 26-year average frequency rate of 21.03.

Rules of the Competition

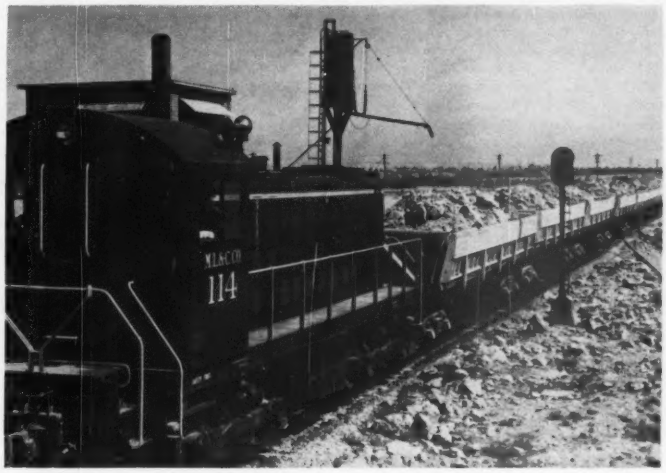
Any mine, open-pit, or quarry operation in the United States is eligible to enter the National Safety Competition. Copies of the contest rules and enrollment applications may be obtained from the Accident Analysis Branch, Bureau of Mines, Washington 25, D. C. To maintain eligibility for the Sentinels of Safety trophy, a plant must have been operated not less than 100 days and have a total worktime of not less than 30,000 man-hours in underground, open-pit, or quarry workings during the contest year. A designated official at each plant must agree to furnish a report of each lost-time or disabling injury and certain employment data to the Bureau of Mines in Washington. Each injury that causes temporary total disability is charged with the number of calendar days that the injured employe is away from work, including Sundays, holidays, and all other days, whether the operation was idle or active.

At the close of the calendar year, the determined injury-severity and injury-frequency rates and a summary of the basic figures from which the rates are derived are sent to each plant for certification by a plant official as to the accuracy and completeness of the original data furnished by the company to the Bureau of Mines.

Committee of Award

Although the rules governing the National Safety Competition are clear and specific, they provide for a Committee of Award, to which committee the records of the leading contestants

(Continued on page 94)



TO THE CRUSHER: A 1,000-hp. Diesel electric locomotive pulls 60-cu. yd. cars loaded with limestone to the primary crusher house.

LAKE CARRIERS: Approximately 98% of the limestone production at Rogers City is transported to Great Lakes ports in boats of 7,000 to 15,000-gross ton capacity.

ALL-TIME WINNERS

ANTHRACITE

1925—Hazle Brook Coal Company, *Upper Lehigh Mine*, Upper Lehigh, Pa.
1926—Jeddo-Highland Coal Company, *Highland No. 6 Mine*, Jeddo, Pa.
1927—Jeddo-Highland Coal Company, *Highland No. 6 Mine*, Jeddo, Pa.
1928—Jeddo-Highland Coal Company, *Highland No. 7 Mine*, Jeddo, Pa.
1929—Jeddo-Highland Coal Company, *Highland No. 6 Mine*, Jeddo, Pa.
1930—Coxe Brothers & Company, Inc., *Tomhicken Mine*, Jeddo, Pa.
1931—Jeddo-Highland Coal Company, *Highland No. 2 Mine*, Jeddo, Pa.
1932—Jeddo-Highland Coal Company, *Highland No. 7 Mine*, Jeddo, Pa.
1933—The Hudson Coal Company, *Stillwater Mine*, Vandling, Pa.
1934—Harleigh-Brookwood Coal Company, *Laurence Mine*, Mahanoy Plane, Pa.
1935—Jeddo-Highland Coal Company, *Jeddo No. 7 Mine*, Harleigh, Pa.
1936—Hazle Brook Coal Company, *Raven Run Mine*, Raven Run, Pa.
1937—Jeddo-Highland Coal Company, *Jeddo No. 7 Mine*, Harleigh, Pa.
1938—Colonial Colliery Company, *Greenough Mine*, Natalie, Pa.
1939—The Hudson Coal Company, *Eddy Creek Mine*, Olyphant, Pa.
1940—Hazle Brook Coal Company, *Midvalley Mine*, Wilburton, Pa.
1941—Eddie & Joe Coal Company, *Eddie & Joe Mine*, Simpson, Pa.
1942—Jeddo-Highland Coal Company, *Stockton Mine*, Stockton, Pa.
1943—Morgan Coal Company, *Oregon Slope Mine*, Pittston, Pa.
1944—The Hudson Coal Company, *Miles Slope Mine*, Dickson City, Pa.
1945—Jermyn-Green Coal Company, *Butler Mine*, Pittston, Pa.
1946—Jermyn-Green Coal Company, *Butler Mine*, Pittston, Pa.
1947—Jermyn-Green Coal Company, *Butler Mine*, Pittston, Pa.
1948—Philadelphia and Reading Coal and Iron Company, *Hunter Tunnel Mine*, Ashland, Pa.
1949—Kehoe-Berge Coal Company, *Stevens Shaft Mine*, Exeter, Pa.
1950—The Hudson Coal Company, *Birdseye Mine, Throop, Pa.*

BITUMINOUS-COAL

1925—United States Coal and Coke Company, *No. 6 Mine*, Gary, W. Va.
1926—United States Coal and Coke Company, *No. 6 Mine*, Gary, W. Va.
1927—United States Coal and Coke Company, *No. 2 Mine*, Gary, W. Va.
1928—United States Coal and Coke Company, *No. 4 Mine*, Gary, W. Va.
1929—DeBardeleben Coal Corporation, *Hull No. 33 Mine*, Dora, Ala.
1930—Penn Central Light and Power Company, *No. 1 Mine*, Coalmont, Pa.
1931—Phelps-Dodge Corporation, *Dawson No. 1 Mine*, Dawson, N. Mex.
1932—Electro Metallurgical Company, Alloy, W. Va.
1933—The Union Pacific Coal Company, *"B" Mine*, Superior, Wyo.
1934—The Union Pacific Coal Company, *"C" Mine*, Superior, Wyo.
1935—Elkhorn Piney Coal Company, *Ingram Branch Mine*, Ingram Branch, W. Va.
1936—The Koppers Coal Company, *Coxton Mine*, Coxton, Ky.
1937—The Union Pacific Coal Company, *"D" Mine*, Superior, Wyo.
1938—The Union Pacific Coal Company, *"B" Mine*, Superior, Wyo.
1939—The Union Pacific Coal Company, *Winton No. 1 Mine*, Winton, Wyo.
1940—The Union Pacific Coal Company, *Rock Springs No. 4 Mine*, Rock Springs, Wyo.
1941—Electro Metallurgical Company, *Alloy No. 2 Mine*, Alloy, W. Va.
1942—Knife River Coal Company, *Knife River Mine*, Beulah, N. Dak.
1943—The Union Pacific Coal Company, *"D" Mine*, Superior, Wyo.
1944—The Union Pacific Coal Company, *"D" Mine*, Superior, Wyo.
1945—Rockhill Coal Company, *Rockhill No. 5 Mine*, Robertsdale, Pa.
1946—Consolidated Coal Company, *Bankhead No. 2 Mine*, Bankhead, Ala.
1947—The Union Pacific Coal Company, *Winton No. 1 and 7¼ Mine*, Winton, Wyo.
1948—The Union Pacific Coal Company, *Reliance No. 7 Mine*, Reliance, Wyo.
1949—The Union Pacific Coal Company, *Reliance No. 7 Mine*, Reliance, Wyo.
1950—The Union Pacific Coal Company, *Reliance No. 7 Mine*, Reliance, Wyo.

METAL

1925—New York Mining Company, *New York Mine* (*zinc and lead*), Picher, Okla.
1926—Federal Mining and Smelting Company, *Muncie Mine* (*zinc and lead*), Baxter Springs, Kans.
1927—The Bristol Mining Company, *Bristol Mine* (*iron*), Crystal Falls, Mich.
1928—Brule Mining Company, *Berkshire Mine* (*iron*), Stambaugh, Mich.
1929—Brule Mining Company, *Berkshire Mine* (*iron*), Stambaugh, Mich.
1930—Penn Iron Mining Company, *West Vulcan Mine*, Vulcan, Mich.
1931—Hanna Ore Mining Company, *Harold Mine*, Carson Lake, Minn.
1932—St. Joseph Lead Company, *Balmat Mine* (*lead, zinc, and pyrites*), Balmat, N. Y.
1933—Tennessee Copper Company, *Burra Burra Mine*, Ducktown, Tenn.
1934—Penn Iron Mining Company, *East Vulcan Mine*, Vulcan, Mich.
1935—Vermillion Mining Company, *Zenith Mine* (*iron*), Ely, Minn.
1936—Penn Iron Mining Company, *East Vulcan Mine*, Vulcan, Mich.
1937—M. A. Hanna Company, *Hiawatha No. 1 Mine* (*iron*), Iron River, Mich.
1938—Odanah Iron Company, *Cary Mine* (*iron*), Hurley, Wis.
1939—M. A. Hanna Company, *Bates Mine* (*iron*), Iron River, Mich.
1940—Phelps-Dodge Corporation, *Humboldt Mine*, Morenci, Ariz.
1941—American Zinc Company of Tennessee, *Grasselli Mine* (*zinc sulphide*), New Market, Tenn.
1942—Tennessee Copper Company, *Boyd Mine*, Ducktown, Tenn.
1943—Penn Iron Mining Company, *East Vulcan Mine*, Vulcan, Mich.
1944—Youngstown Mines Corporation, *Newport Mine* (*iron*), Ironwood, Mich.
1945—James Mining Company, *James Mine* (*iron*), Iron River, Mich.
1946—Tennessee Copper Company, *Burra Burra Copper Mine*, Ducktown, Tenn.
1947—Oliver Iron Mining Company, *Soudan Mine*, Soudan, Minn.
1948—Oliver Iron Mining Company, *Fraser Mine*, Fraser, Minn.
1949—American Zinc Company of Tennessee, *No. 2 Mine*, Mascot, Tenn.
1950—Republic Steel Corporation, *Tobin Mine*, Crystal Falls, Mich.

NONMETALLIC

1925—United States Gypsum Company, *Lower Gypsum Mine*, Gypsum, Ohio.
1926—The Beaver Products Company, Inc., *Grand Rapids Mine* (*gypsum*), Grand Rapids, Mich.
1927—The Marquette Cement Manufacturing Company, *La Salle Mine* (*limestone*), Oglesby, Ill.
1928—Alpha Portland Cement Company, *Ironton Mine* (*limestone*), Ironton, Ohio.
1929—Retsof Mining Company, *Retsof Mine* (*rock salt*), Retsof, N. Y.
1930—United States Gypsum Company, *Lower Gypsum Mine*, Gypsum, Ohio.
1931—Retsof Mining Company, *Retsof Mine* (*rock salt*), Retsof, N. Y.
1932—Retsof Mining Company, *Retsof Mine* (*rock salt*), Retsof, N. Y.
1933—Retsof Mining Company, *Retsof Mine* (*rock salt*), Retsof, N. Y.
1934—The Marquette Cement Manufacturing Company, *La Salle Mine* (*limestone*), Oglesby, Ill.
1935—Certain-teed Products Corporation, *Gypsum Mine*, Akron, N. Y.
1936—Tennessee Coal, Iron & Railroad Company, *No. 5 Mine* (*limestone*), Bessemer, Ala.
1937—Tennessee Coal, Iron & Railroad Company, *No. 5 Mine* (*limestone*), Bessemer, Ala.
1938—Avery Salt Company, Avery Island, La.
1939—Tennessee Coal, Iron & Railroad Company, *No. 5 Mine* (*limestone*), Bessemer, Ala.
1940—Tennessee Coal, Iron & Railroad Company, *No. 5 Mine* (*limestone*), Bessemer, Ala.
1941—United States Gypsum Company, *No. 6 Mine* (*gypsum*), Plasterco, Va.
1942—Alpha Portland Cement Company, *Ironton Mine* (*limestone*), Ironton, Ohio.
1943—United States Gypsum Company, *No. 6 Mine* (*gypsum*), Plasterco, Va.
1944—National Gypsum Company, *Akron Gypsum Mine*, Akron, N. Y.
1945—Freeport Brick Company, *Freeport Mine* (*clay*), Freeport, Pa.
1946—Certain-teed Products Corporation, *Acme Gypsum Mine*, Acme, Texas.
1947—Tennessee Coal, Iron & Railroad Company, *No. 5 Mine* (*limestone*), Bessemer, Ala.
1948—Alpha Portland Cement Company, *Ironton Mine*, Ironton, Ohio.
1949—National Gypsum Company, *Bellefonte Mine*, Bellefonte, Pa
1950—Pittsburgh Plate Glass Company, *Barberton Limestone Mine*, Barberton, Ohio.

OPEN-PIT AND QUARRIES

1925—North American Cement Corporation, *Security Quarry* (*limestone*), Security, Md.
1926—North American Cement Corporation, *No. 5 and 6 Quarry* (*limestone*), Martinsburg, W. Va.
1927—Lehigh Portland Cement Company, *Mitchell Quarry* (*limestone*), Mitchell, Ind.
1928—Wakefield Iron Company, *Wakefield Open-pit Mine* (*iron*), Wakefield, Mich.
1929—Michigan Limestone & Chemical Company, *Rogers City Quarry* (*limestone*), Rogers City, Mich.
1930—Plymouth Mining Company, *Plymouth Open-pit* (*iron*), Wakefield, Mich.
1931—Mahoning Ore & Steel Company, *Mahoning Open-pit Mine* (*iron*), Hibbing, Minn.
1932—Michigan Limestone & Chemical Company, *Rogers City Quarry* (*limestone*), Rogers City, Mich.
1933—Michigan Limestone & Chemical Company, *Rogers City Quarry* (*limestone*), Rogers City, Mich.
1934—Michigan Limestone & Chemical Company, *Rogers City Quarry* (*limestone*), Rogers City, Mich.
1935—Folsom State Prison, *Granite Quarry*, Folsom, Calif.
1936—Hanna Ore Mining Company, *Mesabi Chief Mine* (*iron*), Keewatin, Minn.
1937—Illinois State Penitentiary, *Limestone Quarry*, Menard, Ill. (Separated into Individual Groups in 1938.)

OPEN-PIT

1938—Pickands Mather & Company, *Mahoning Mine* (*iron-ore*), Hibbing, Minn.
1939—Pickands Mather & Company, *Scranton Mine* (*iron-ore*), Hibbing, Minn.
1940—Pickands Mather & Company, *Mahoning Mine* (*iron-ore*), Hibbing, Minn.
1941—Pickands Mather & Company, *Mahoning Mine* (*iron-ore*), Hibbing, Minn.
1942—Pickands Mather & Company, *Mahoning Mine*, Hibbing, Minn.
1943—Pickands Mather & Company, *Danube Mine*, Bovey, Minn.
1944—Pickands Mather & Company, *Danube Mine*, Bovey, Minn.
1945—Pickands Mather & Company, *Mahoning Mine*, Hibbing, Minn.
1946—Oliver Iron Mining Company, *Rouchleau Iron-ore Pit*, Virginia, Minn.
1947—Pickands Mather & Company, *Mahoning Mine*, Hibbing, Minn.
1948—Oliver Iron Mining Company, *Spruce Open-cut Mine*, Eveleth, Minn.
1949—Pickands Mather & Company, *Embarrass Mine*, Biwabik, Minn
1950—Pickands Mather & Company, *Embarrass Mine*, Biwabik, Minn.

QUARRIES

1938—Inland Lime & Stone Company, *Port Inland Quarry* (*limestone*), Manistique, Mich.
1939—Inland Lime & Stone Company, *Port Inland Quarry* (*limestone*), Manistique, Mich.
1940—Tennessee Coal, Iron & Railroad Company, *Dolonah Quarry* (*dolomite*), Bessemer, Ala.
1941—Tennessee Coal, Iron & Railroad Company, *Dolonah Quarry* (*dolomite*), Bessemer, Ala.
1942—Bethlehem Steel Company, *Hanover Quarry*, Hanover, Pa.
1943—Wyandotte Chemicals Corporation, *Alpena Quarry*, Alpena, Mich.
1944—Basic Refractories, Inc., *Maple Grove Quarry* (*dolomite*), Maple Grove, Ohio.
1945—Bethlehem Steel Company, *Bridgeport Quarry* (*limestone*), Bridgeport, Pa.
1946—Bethlehem Steel Company, *Bridgeport Quarry* (*limestone*), Bridgeport, Pa.
1947—Tennessee Coal, Iron & Railroad Company, *Dolonah Quarry* (*dolomite*), Bessemer, Ala.
1948—Bethlehem Steel Company, *Hanover Quarry*, Hanover, Pa.
1949—Tennessee Coal, Iron & Railroad Company, *Dolonah Quarry*, (*dolomite*), Bessemer, Ala.
1950—Michigan Limestone & Chemical Company, *Rogers City Quarry* (*Limestone*), Rogers City, Mich.

Awards of Certificates of Achievement

IN SAFETY

The rules of the competition provide for the award of Certificates of Achievement in Safety to each mine or quarry, other than the trophy winners, whose position in the contest was among the first four in their respective groups. Certificates are also awarded to each injury-free mine or quarry that worked 30,000 or more man-hours during the twelve consecutive months of each contest. The winners of Certificates of Achievement in Safety, in the National Safety Competition of 1950, are as follows:

ANTHRACITE

North Line mine, Shamokin, Northumberland County, Pa., operated by North Line Coal Co., worked 36,078 man-hours with 4 disabling injuries that caused 13 days of disability. The injury-severity rate was 0.360.

Pine Grove mine, Pine Grove, Schuylkill County, Pa., operated by Penag Coal Co., worked 46,732 man-hours with 3 disabling injuries that caused 18 days of disability. The injury-severity rate was 0.385.

Hunter Tunnel mine, Ashland, Schuylkill County, Pa., operated by Philadelphia & Reading Coal & Iron Co., worked 101,458 man-hours with 1 disabling injury that caused 96 days of disability. The injury-severity rate was 0.946.

St. Clair Colliery, St. Clair, Schuylkill County, Pa., operated by The St. Clair Coal Co., worked 452,618 man-hours with 27 disabling injuries that caused 505 days of disability. The injury-severity rate was 1.116.

BITUMINOUS-COAL

Thacker mine, Williamson, Mingo County, W. Va., operated by the Pond Creek Colliery of the N. & W. Railway Co., worked 253,648 man-hours without a disabling injury.

Rock Springs No. 8 mine, Rock Springs, Sweetwater County, Wyo., operated by The Union Pacific Coal Co., worked 205,487 man-hours without a disabling injury.

Winifrede mine, Williamson, Mingo County, W. Va., operated by Pond Creek Colliery of the N. & W. Railway Co., worked 188,700 man-hours without a disabling injury.

Rockhill No. 5 mine, Robertsdale, Huntingdon County, Pa., operated by Rockhill Coal Co., worked 147,448 man-hours without a disabling injury.

Sayreton No. 2 mine, Sayreton, Jefferson County, Ala., operated by Republic Steel Corp., worked 111,638 man-hours without a disabling injury.

Dawson No. 6 mine, Dawson, Colfax County, N. Mex., operated by Stag Canon Branch of the Phelps Dodge Corp., worked 66,121 man-hours without a disabling injury.

Patton Clay Mine No. 1, Patton, Cambria County, Pa., operated by Patton Clay Manufacturing Co., worked 36,589 man-hours without a disabling injury.

METAL

Ironton iron-ore mine, Bessemer, Gogebic County, Mich., operated by Pickands Mather & Co. (Puritan Mining Co.), worked 231,457 man-hours without a disabling injury.

Burra-Burra copper sulphide ore mine, Ducktown, Polk County, Tenn., operated by Tennessee Copper Co., worked 229,809 man-hours without a disabling injury.

Bennett iron-ore mine, Keewatin, Itasca County, Minn., operated by Pickands Mather & Co. (Bennett Mining Co.), worked 201,761 man-hours without a disabling injury.

James iron-ore mine, Iron River, Iron County, Mich., operated by Pickands Mather & Co. (James Mining Co.), worked 162,757 man-hours without a disabling injury.

Jarnagin zinc sulphide in dolomite limestone mine, Jefferson City, Jefferson County, Tenn., operated by American Zinc Co. of Tennessee, worked 96,485 man-hours without a disabling injury.

NONMETALLIC

Kimballton lime mine, Kimballton, Giles County, Va., operated by The Standard Lime & Stone Co., worked 172,964 man-hours without a disabling injury.

Kimballton lime mine, Kimballton, Giles County, Va., operated by National Gypsum Co., worked 150,547 man-hours without a disabling injury.

Sugar Creek limestone and shale mine, Sugar Creek, Jackson County, Mo., operated by Missouri Portland Cement Co., worked 125,489 man-hours without a disabling injury.

Winnfield salt mine, Winnfield, Winn County, La., operated by The Carey Salt Co., worked 90,030 man-hours without a disabling injury.

Crestmore limestone mine, Riverside, Riverside County, Calif., operated by Riverside Cement Co., worked 79,965 man-hours without a disabling injury.

Manheim cement rock mine, Manheim, Preston County, W. Va., operated by Alpha Portland Cement Co., worked 75,797 man-hours without a disabling injury.

Grand Rapids Gypsum mine, Grand Rapids, Kent County, Mich., operated by Certain-teed Products Corp., worked 67,680 man-hours without a disabling injury.

Charmian greenstone mine, Blue Ridge Summit, Franklin County, Pa., operated by The Funkhouser Co., worked 63,270 man-hours without a disabling injury.

No. 3 shale mine, Hannibal, Ralls County, Mo., operated by Universal Atlas Cement Co., worked 51,162 man-hours without a disabling injury.

Hutchinson salt mine, Hutchinson, Reno County, Kans., operated by The Carey Salt Co., worked 45,251 man-hours without a disabling injury.

Acme gypsum mine, Acme, Hardeman County, Tex., operated by Certain-teed Products Corp., worked 43,981 man-hours without a disabling injury.

Fairmount slate mine, Fairmount, Bartow County, Ga., operated by The Funkhouser Co., worked 43,740 man-hours without a disabling injury.

Marblehead agricultural limestone mine, Marblehead, Adams County, Ill., operated by Marblehead Lime Co., worked 32,532 man-hours without a disabling injury.

OPEN-PIT

Mahoning iron-ore mine, Hibbing, St. Louis County, Minn., operated by Pickands Mather & Co. (Mahoning Ore & Steel Co.), worked 537,080 man-hours without a disabling injury.

Canton iron-ore mine, Biwabik, St. Louis County, Minn., operated by Oliver Iron Mining Co., worked 350,404 man-hours without a disabling injury.

Scranton iron-ore mine, Hibbing, St. Louis County, Minn., operated by Pickands Mather & Co. (Hoyt Mining Co.), worked 345,043 man-hours without a disabling injury.

Buckeye iron-ore mine, Coleraine, Itasca County, Minn., operated by The M. A. Hanna Co. (Hanna Ore Mining Co.), worked 227,966 man-hours without a disabling injury.

Sagamore iron-ore mine, Riverton, Crow Wing County, Minn., operated by Pickands Mather & Co. (Sagamore Ore Mining Co.), worked 205,495 man-hours without a disabling injury.

Corsica iron-ore mine, Elcor, St. Louis County, Minn., operated by Pickands Mather & Co. (Corsica Iron Co., worked 177,587 man-hours without a disabling injury.

Longyear iron-ore mine, Hibbing, St. Louis County, Minn., operated by Inter-State Iron Co., worked 173,178 man-hours without a disabling injury.

Plymouth iron-ore mine, Wakefield, Gogebic County, Mich., operated by Pickands Mather & Co. (Plymouth Mining Co.), worked 158,085 man-hours without a disabling injury.

Fayal iron-ore mine, Eveleth, St. Louis County, Minn., operated by Oliver Iron Mining Co., worked 147,043 man-hours without a disabling injury.

Pauway No. 4 phosphate rock mine, Lakeland, Polk County, Fla., operated by The Davison Chemical Corp., worked 121,824 man-hours without a disabling injury.

Bonny Lake phosphate rock mine, Bartow, Polk County, Fla., operated by The Davison Chemical Corp., worked 107,360 man-hours without a disabling injury.

Arcturus iron-ore mine, Marble, Itasca County, Minn., operated by Oliver Iron Mining Co., worked 86,275 man-hours without a disabling injury.

Monsanto phosphate matrix mines, Columbia, Maury County, Tenn., operated by Monsanto Chemical Co., worked 79,302 man-hours without a disabling injury.

Armour No. 2 iron-ore mine, Ironton, Crow Wing County, Minn., operated by Inland Steel Co., worked 65,186 man-hours without a disabling injury.

Monitor Extension Stripping anthracite mine, Locust Gap, Northumberland County, Pa., operated by Philadelphia & Reading Coal & Iron Co., worked 62,370 man-hours without a disabling injury.

Pillsbury iron-ore mine, Chisholm, St. Louis County, Minn., operated by Oliver Iron Mining Co., worked 57,715 man-hours without a disabling injury.

Virginia iron-ore mine, Eveleth, St. Louis County, Minn., operated by Snyder Mining Co., worked 56,941 man-hours without a disabling injury.

Richmond iron-ore mine, Palmer, Marquette County, Mich., operated by Richmond Iron Co. (The M. A. Hanna Co.), worked 52,459 man-hours without a disabling injury.

Sayre Strip bituminous-coal mine, Sayre, Jefferson County, Ala., operated by Republic Steel Corp., worked 44,114 man-hours without a disabling injury.

Volunteer iron-ore mine, Palmer, Marquette County, Mich., operated by Pickands Mather & Co. (Palmer Mining Co.), worked 41,220 man-hours without a disabling injury.

QUARRIES

Bridgeport limestone quarry, Bridgeport, Montgomery County, Pa., operated by Bethlehem Steel Co., worked 356,758 man-hours without a disabling injury.

Columbia limestone Quarry No. 1, Columbia, St. Clair County, Ill., operated by Columbia Quarry Co., worked 228,758 man-hours without a disabling injury.

Naginey limestone quarry, Naginey, Mifflin County, Pa., operated by Bethlehem Steel Co., worked 217,548 man-hours without a disabling injury.

Bailey Falls limestone quarry, Oglesby, LaSalle County, Ill., operated by Marquette Cement Manufacturing Co., worked 183,776 man-hours without a disabling injury.

No. 5 limestone quarry, Hannibal, Ralls County, Mo., operated by Universal Atlas Cement Co., worked 177,231 man-hours without a disabling injury.

No. 4 cement-rock quarry, Nazareth, Northampton County, Pa., operated by Pennsylvania-Dixie Cement Corp., worked 167,315 man-hours without a disabling injury.

Frazier limestone quarry, East Fultonham, Muskingum County, Ohio, operated by Columbia Cement Division of the Pittsburgh Plate Glass Co., worked 163,034 man-hours without a disabling injury.

Steelton limestone quarry, Steelton, Dauphin County, Pa., operated by Bethlehem Steel Co., worked 150,887 man-hours without a disabling injury.

Gate City limestone quarry, Gate City, Scott County, Va., operated by Pennsylvania-Dixie Cement Corp., worked 137,468 man-hours without a disabling injury.

No. 1 limestone quarry, Coeymans, Albany County, N. Y., operated by Callanan Road Improvement Co., worked 115,412 man-hours without a disabling injury.

Dixon limestone quarry, Dixon, Lee County, Ill., operated by Medusa Portland Cement Co., worked 113,941 man-hours without a disabling injury.

Ohio dolomite quarry, Millersville, Sandusky County, Ohio, operated by The J. E. Baker Co., worked 108,466 man-hours without a disabling injury.

Jensen limestone quarry, Riverside, Riverside County, Calif., operated by Riverside Cement Co., worked 102,020 man-hours without a disabling injury.

Fogelsville limestone and cement stone quarry, Fogelsville, Lehigh County, Pa., operated by Lehigh Portland Cement Co., worked 103,388 man-hours without a disabling injury.

Klondike limestone quarry, Oro Grande, San Bernardino County, Calif., operated by Riverside Cement Co., worked 102,428 man-hours without a disabling injury.

Wampum limestone quarry, Wampum, Lawrence County, Pa., operated by Medusa Portland Cement Co., worked 101,760 man-hours without a disabling injury.

Southwestern limestone quarry, Fairborn, Greene County, Ohio, operated by Southwestern Portland Cement Co., worked 100,696 man-hours without a disabling injury.

Clinchfield limestone quarry, Clinchfield, Houston County, Ga., operated by Pennsylvania-Dixie Cement Corp., worked 97,878 man-hours without a disabling injury.

North Branford No. 7 crushed trap rock quarry, North Branford, New Haven County, Conn., operated by The New Haven Trap Rock Co., worked 95,890 man-hours without a disabling injury.

Bethlehem limestone quarry, Bethlehem, Northampton County, Pa., operated by Bethlehem Steel Co., worked 94,240 man-hours without a disabling injury.

Billmeyer dolomite quarry, Bainbridge, Lancaster County, Pa., operated by The J. E. Baker Co., worked 91,904 man-hours without a disabling injury.

Oglesby limestone quarry, Oglesby, La Salle County, Ill., operated by Lehigh Portland Cement Co., worked 90,145 man-hours without a disabling injury.

Gibsonburg lime and limestone quarry, Gibsonburg, Sandusky County, Ohio, operated by The Kelley Island Lime & Transport Co., worked 88,433 man-hours without a disabling injury.

Martins Creek cement rock quarry, Martins Creek, Northampton County, Pa., operated by Alpha Portland Cement Co., worked 88,028 man-hours without a disabling injury.

Davenport limestone quarry, Linwood, Scott County, Iowa, operated by Dewey Portland Cement Co., worked 86,576 man-hours without a disabling injury.

Nazareth cement rock quarry, Nazareth, Northampton County, Pa., operated by Lone Star Cement Corp., worked 85,734 man-hours without a disabling injury.

Stockertown cement rock quarry, Stockertown, Northampton County, Pa., operated by Hercules Cement Corp., worked 84,720 man-hours without a disabling injury.

Portland limestone and shale quarry, Portland, Fremont County, Colo., operated by Ideal Cement Co., worked 83,516 man-hours without a disabling injury.

Watertown limestone quarry, Watertown, Jefferson County, N. Y., operated by The General Crushed Stone Co., worked 82,495 man-hours without a disabling injury.

No. 3 cement rock quarry, West Coplay, Lehigh County, Pa., operated by Coplay Cement Manufacturing Co., worked 81,503 man-hours without a disabling injury.

Ormrod limestone and cement stone quarry, Ormrod, Lehigh County, Pa., operated by Lehigh Portland Cement Co., worked 79,391 man-hours without a disabling injury.

Dallas limestone quarry, Dallas, Dallas County, Tex., operated by Trinity Portland Cement Division of the General Portland Cement Co., worked 79,274 man-hours without a disabling injury.

Monroe crushed stone quarry, Monroe, Monroe County, Mich., operated by The France Stone Co., worked 78,368 man-hours without a disabling injury.

Northampton cement rock quarry, Northampton, Northampton County, Pa., operated by Universal Atlas Cement Co., worked 78,006 man-hours without a disabling injury.

Silica crushed stone quarry, Sylvania, Lucas County, Ohio, operated by Toledo Stone & Glass Sand Co., worked 76,014 man-hours without a disabling injury.

Martha limestone quarry, Lebanon, Wilson County, Tenn., operated by Marquette Cement Manufacturing Co., worked 74,075 man-hours without a diabling injury.

Petoskey crushed limestone quarry, Petoskey, Emmet County, Mich., operated by Petoskey Portland Cement Co., worked 73,521 man-hours without a disabling injury.

Oriskany Falls limestone No. 5 quarry, Oriskany Falls, Oneida County, N. Y., operated by Eastern Rock Products, Inc., worked 71,588 man-hours without a disabling injury.

Greencastle limestone quarry, Greencastle, Putnam County, Ind., operated by Lone Star Cement Corp., worked 70,005 man-hours without a disabling injury.

LaSalle cement rock quarry, LaSalle, LaSalle County, Ill., operated by Alpha Portland Cement Co., worked 69,341 man-hours without a disabling injury.

Keystone cement rock quarry, Bath, Northampton County, Pa., operated by Keystone Portland Cement Co., worked 68,923 man-hours without a disabling injury.

Auburn limestone quarry, Auburn, Cayuga County, N. Y., operated by The General Crushed Stone Co., worked 68,848 man-hours without a disabling injury.

Fort Worth limestone quarry, Fort Worth, Tarrant County, Tex., operated by Trinity Portland Cement Division of the General Portland Cement Co., worked 68,812 man-hours without a disabling injury.

Marquette limestone quarry, Earlham, Madison County, Iowa, operated by Marquette Cement Manufacturing Co., worked 67,943 man-hours without a disabling injury.

Inwood limestone quarry, Inwood, Berkeley County, W. Va., operated by The J. E. Baker Co., worked 66,325 man-hours without a disabling injury.

Thomaston limestone quarry, Thomaston, Knox County, Maine, operated by Lawrence Portland Cement Co., worked 64,565 man-hours without a disabling injury.

Jordanville limestone quarry, Jordanville, Herkimer County, N. Y., operated by The General Crushed Stone Co., worked 64,295 man-hours without a disabling injury.

Galloway lime & rock quarry, Galloway, Greene County, Mo., operated by Ash Grove Lime & Portland Cement Co., worked 63,925 man-hours without a disabling injury.

Keeport crushed stone quarry, Logansport, Cass County, Ind., operated by The France Stone Co., worked 63,769 man-hours without a disabling injury.

Blue Mount trap rock quarry, Blue Mount, Baltimore County, Md., operated by The J. E. Baker Co., worked 63,104 man-hours without a disabling injury.

Birmingham limestone quarry, Birmingham, Jefferson County, Ala., operated by Lone Star Cement Corp., worked 62,155 man-hours without a disabling injury.

Hudson limestone quarry, Hudson, Columbia County, N. Y., operated by Lone Star Cement Corp., worked 60,552 man-hours without a disabling injury.

Sylvania limestone quarry, Sylvania, Lucas County, Ohio, operated by Medusa Portland Cement Co., worked 59,821 man-hours without a disabling injury.

Superior limestone quarry, Superior, Nuckolls County, Nebr., operated by Ideal Cement Co., worked 58,250 man-hours without a disabling injury.

Huntington crushed stone quarry, Huntington, Huntington County, Ind., operated by The Erie Stone Co., worked 58,050 man-hours without a disabling injury.

Sandt's Eddy cement rock quarry, Easton, Northampton County, Pa., operated by Lehigh Portland Cement Co., worked 57,242 man-hours without a disabling injury.

Genoa dolomite limestone quarry, Genoa, Ottawa County, Ohio, operated by United States Gypsum Co., worked 57,080 man-hours without a disabling injury.

Gibsonburg lime & limestone quarry, Gibsonburg, Sandusky County, Ohio, operated by National Mortar & Supply Co., worked 55,320 man-hours without a disabling injury.

National City gypsum rock quarry, National City, Iosco County, Mich., operated by National Gypsum Co., worked 53,720 man-hours without a disabling injury.

Middlefield No. 1 crushed trap rock quarry, Middlefield, New Haven County, Conn., operated by New Haven Trap Rock Co., worked 53,683 man-hours without a disabling injury.

Birmingham cement rock quarry, Birmingham, Northampton County, Pa., operated by Alpha Portland Cement Co., worked 53,231 man-hours without a disabling injury.

Bethlehem cement rock quarry, Bethlehem, Northampton County, Pa., operated by National Portland Cement Co., worked 52,992 man-hours without a disabling injury.

Sugar Creek limestone & shale quarry, Sugar Creek, Jackson County, Mo., operated by Missouri Portland Cement Co., worked 52,793 man-hours without a disabling injury.

Bennie and Harvey monumental stone quarry, Lexington, Oglethorpe County, Ga., operated by Bennie & Harvey Co., worked 52,640 man-hours without a disabling injury.

Thomasville crushed stone quarry, Thomasville, York County, Pa., operated by The J. E. Baker Co., worked 51,608 man-hours without a disabling injury.

Zanesville limestone quarry, White Cottage, Muskingum County, Ohio, operated by Sidwell Brothers Co., worked 50,400 man-hours without a disabling injury.

Devil's Slide limestone quarry, Morgan, Morgan County, Utah, operated by Ideal Cement Co., worked 50,032 man-hours without a disabling injury.

Iola limestone and shale quarry, Iola, Allen County, Kans., operated by Lehigh Portland Cement Co., worked 47,580 man-hours without a disabling injury.

St. Cloud Ballast granite quarry, Waite Park, Stearns County, Minn., operated by Shiely-Petters Crushed Stone Co., worked 46,720 man-hours without a disabling injury.

Lehigh Limestone and Brownstown Shale quarry, Mitchell and Brownstown, Lawrence and Jackson Counties, Ind., operated by Lehigh Portland Cement Co., worked 46,365 man-hours without a disabling injury.

Charmian greenstone quarry, Blue Ridge Summit, Franklin County, Pa., operated by The Funkhouser Co., worked 46,170 man-hours without a disabling injury.

Marquette limestone quarry, Cape Girardeau, Cape Girardeau County, Mo., operated by Marquette Cement Manufacturing Co., worked 45,112 man-hours without a disabling injury.

Spencer crushed stone quarry, Spencer, Owen County, Ind., operated by France Stone Products Inc., worked 43,595 man-hours without a disabling injury.

Union Bridge limestone quarry, Union Bridge, Frederick and Carroll Counties, Md., operated by Lehigh Portland Cement Co., worked 42,876 man-hours without a disabling injury.

Bluffton crushed stone quarry, Bluffton, Wells County, Ind., operated by The Erie Stone Co., worked 40,263 man-hours without a disabling injury.

Howes Cave limestone quarry, Howes Cave, Scoharie County, N. Y., operated by North American Cement Corp., worked 39,438 man-hours without a disabling injury.

Evansville cement rock quarry, Evansville, Berks County, Pa., operated by Allentown Portland Cement Co., worked 39,103 man-hours without a disabling injury.

Boettcher limestone and shale quarry, Ft. Collins, Larimer County, Colo., operated by Ideal Cement Co., worked 37,705 man-hours without a disabling injury.

Evans limestone quarry, Evans, Stevens County, Wash., operated by United States Gypsum Co., worked 37,460 man-hours without a disabling injury.

No. 4 trap rock quarry, Knippa, Uvalde County, Tex., operated by Southwest Stone Co., worked 35,759 man-hours without a disabling injury.

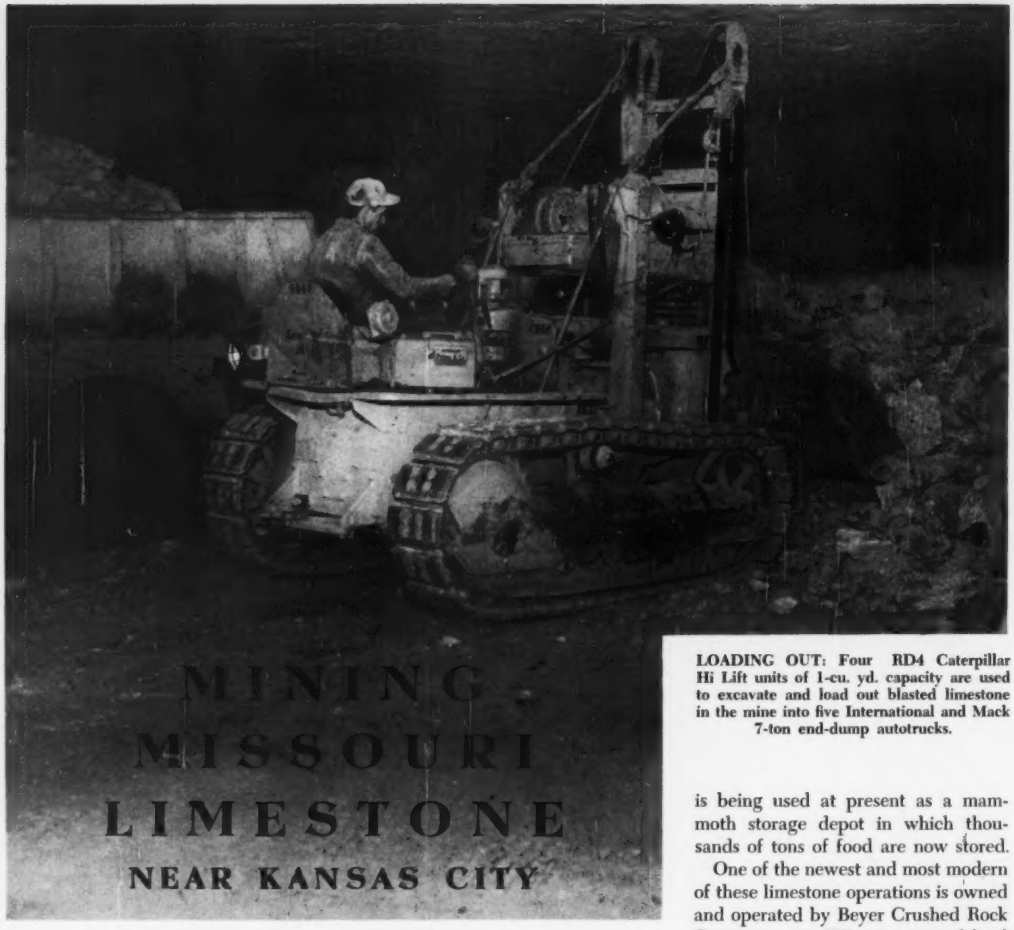
Knoxville lime quarry, Knoxville, Knox County, Tenn., operated by The Standard Lime & Stone Co., worked 35,400 man-hours without a disabling injury.

Elberton dimension granite quarry, Elberton, Oglethorpe County, Ga., operated by Dixie Granite Quarriers, worked 34,000 man-hours without a disabling injury.

Middle Falls crushed stone quarry, Middle Falls, Washington County, N. Y., operated by Hudson Valley Sand & Stone Co., worked 33,000 man-hours without a disabling injury.

Montgomeryville trap rock quarry, Montgomeryville, Montgomery County, Pa., operated by Montgomery Stone Co., worked 32,600 man-hours without a disabling injury.

Georgetown limestone quarry, Georgetown, Harrison County, Ohio, operated by Hanna Coal Co. (Div. of Pittsburgh Consolidation Coal Co., worked 32,379 man-hours without a disabling injury.



MINING MISSOURI LIMESTONE NEAR KANSAS CITY

LOADING OUT: Four RD4 Caterpillar Hi Lift units of 1-cu. yd. capacity are used to excavate and load out blasted limestone in the mine into five International and Mack 7-ton end-dump autotrucks.

Underground operations in the area make possible a production of more than 15,000 tons of prepared sizes of limestone each day

FARRELL CASTELLANI*

With production averaging more than 15,000 tons each day, the underground mining of limestone and its processing for industrial uses have contributed substantially to the growth and development of Kansas City, Missouri, and surrounding communities.

*Hercules Powder Company, Pittsburg, Kansas.

It is estimated that these mining activities have resulted in approximately 3,000 acres of man-made caves in the area. Since the ceilings are 12 ft. or more in height and the interiors dry, these caves provide excellent facilities for the storage of food and for shelter against bombs in the event of air raids by enemy forces. One of the caves is being used at present as a mammoth storage depot in which thousands of tons of food are now stored.

One of the newest and most modern of these limestone operations is owned and operated by Beyer Crushed Rock Company on a 551-acre tract of land 5 miles south of Kansas City, on U. S. Highway 71. Underlying the property are reserves of concrete specification limestone estimated at more than 15,000,000 tons.

The company recovers the limestone by underground mining in a 12-ft.-thick stratum of limestone known locally as the Bethany ledge. This formation is hard and brittle. Overlying it is the Winterset ledge, a variable formation with a maximum thickness of 27 ft. The coverage over the Bethany ledge ranges from 10 to 100 ft.

Mining Procedures

The room-and-pillar system of mining is used, with rooms 30 ft. wide and

DRILLING: Holes for blasting in the underground working faces are drilled with one-man-operated Sullivan truck-mounted 350-c.f.m. jib units with 1⅞- and 1½-in. bits.

pillars 20 ft. wide. As the mining activities advance, the rooms will be widened to a maximum of 45 ft.

The slab method of drilling is followed, and the depth of the holes varies, gradually increasing to a maximum depth of 12 ft. as the drill pattern fans out. The height of ceilings, or roofs, in rooms is governed by the natural parting of the limestone; the floor is shale.

Holes for blasting in the working faces are drilled with four Sullivan truck-mounted 350-c.f.m. jib units, with 1⅞- and 1½-in. bits. Two lengths of steel, 6 and 12 ft., are used. The drills are one-man operated, and drilling speed averages about 2 ft. a minute. Air for the drills is supplied by a 1,300-c.f.m. electrically driven stationary Ingersoll-Rand compressor plant located outside the mine. The air is piped to the drills inside the mines.

Holes for blasting are drilled in rows across the top, the center, and the bottom of a working face, usually with 7 holes in each row. The bottom row starts about 1 ft. above the floor, dipping downward to end at the floor level. The middle row begins 5½ ft. above the bottom row and the holes are angled slightly upward. The top row starts 2 ft. below the roof with the holes directed upward to finish in the roof. In each row, the holes are spaced approximately 3½ ft. apart. In the middle row, the center hole is drilled slightly ahead of the center holes in the top and bottom rows. When a blast is fired, it is always the first hole to be detonated.

Cap-and-Fuse Primers

The drill holes are loaded with Hercomite* 5X, in 1¼ by 8-in. cartridges, on a ratio of 1 lb. of dynamite to 2.1 tons of limestone in the solid. The charges are primed with No. 6 Blasting Caps and Orange Wax Clover

*Reg. U. S. Pat. Off.

TO THE PLANT: One of the company's 7-ton capacity end-dump trucks, loaded with blasted limestone from the mine, is on its way to the modern preparation plant.

THE PLANT: The limestone is dumped onto an automatic feeder for delivery to a gyratory crusher. From there it moves over screens to the preparation plant for grading into eight sizes of marketable limestone.

safety fuse. After a round has been loaded and primed, the shot firer cuts the safety fuse extending from each hole to the length desired to attain the proper order of firing.

Short-Period Delay Caps

A system of drilling and blasting new to this area was introduced recently. It involves drilling a V-cut round in a face, and priming the dynamite charges with Short-Period Delay Electric Blasting Caps to detonate the charges. The overall cost of blasting by this method has proved to be economical for several reasons: The increase in the initial cost of the Short-Period Delay Caps is offset by the saving in time and expense entailed in making up the cap-and-fuse detonators; by better breakage; a more uniform yield in tonnage per round; and the minimizing of throw rock from blasts. Also, the new method enables the crews to drill and load each round in the same manner for each blast. This, of course, helps to minimize the margin of human error. In using the new method, Short-Period Delay Electric Blasting Caps Nos. 1 to 9 inclusive are employed, depending on the width and the height of the room working face and the number of holes in a round.

Recovering the Limestone

After a blast, the broken limestone is loaded out by four RD4 Caterpillar Hi Lift units of 1-cu. yd. capacity, into five gasoline-driven International K11 and Mack LJT end-dump trucks, each of 7-ton capacity. The trucks dump their loads into a 4 by 20-ft. automatic feeder that delivers the stone to a No. 30 Kennedy gyratory crusher with a capacity of 400 tons an hour. From the primary crusher the stone is moved over a scalping screen onto a Simon cone 4¼ secondary crusher, then up a bucket elevator and back again over the scalping screen. The screened stone is then moved on a belt conveyor to the main preparation plant, where four 4 by 12-ft. Deister screens grade it into eight sizes of marketable limestone, ranging from dust to 2 in.

OPERATING DIRECTORS: At right, Louis Marino, one of the owners of the company and its general manager, is photographed with Superintendent Alva Hill.

READY TO BLAST: The drill holes in the face are loaded with 1¼ by 8-in. cartridges of Hercomite 5X on a ratio of 1 lb. of dynamite to 2.1 tons of limestone in the solid.

Beyer Crushed Rock Company is owned by Louis Marino, E. J. Flinn, and James Hoover, with headquarters in Kansas City. Mr. Marino is the company's general manager; Alva Hill is superintendent of operations.

NAPALM BOMB: A napalm bomb bursts with awful destruction upon a group of barracks sheltering U. N. enemies in Korea. Called "jellied hell," this form of pyrotechnics is one of the most frequently used weapons to overcome the numerical superiority of the enemy.

MODERN PYROTECHNICS GO TO WAR IN KOREA

New, spectacular munitions have produced fabulous results in the Korean campaign

MEL WHARTON*

ONE OF THE outstanding features of the Korean campaign is the development and use of pyrotechnics. These "fireworks" have produced fabulous results and are credited, in part, with the astonishingly low United Nations casualty rate in comparison with that of the Communist foe.

The employment of spectacular military pyrotechnics has enabled United Nations troops in Korea, though outnumbered three to one, not only to contain their common enemy but to make advances against the fanatical Red horde.

Every combat branch of the United States military and naval establishment enters into this "Flash Gordonish" picture. Pyrotechnics go into battle with infantry, tanks, artillery, air and naval forces. They are shot from guns, rockets, bazookas, mortars, or tossed by hand. This fantastic warfare consists of lighting smoke pots, generating artificial fog, and creating cloud screens either to blind the enemy or to render friendly forces invisible. So great an advantage has been gained by our pyrotechnic weapons that some military experts estimate that one U. N. soldier is now equal to about four of the foe.

These weapons exist for every war purpose: casualty, deception, signal, rescue, incendiary, screening, protection, and training. Smoke has been designed to pillar high, spread flat, flow into depressions, or climb hills. These amazing arms are the product of the scientific age in which we live. Behind their conception are the combined talents of physicists, chemists, engineers, and tacticians. They are the result of collaboration between industry and the military.

Napalm

Napalm, "jellied hell," is one of the most frequently used fireworks to overcome the numerical superiority of the enemy. It is a jellied gasoline, a kind of soap that looks like brown jello. It clings, burning everything it strikes, even tanks, and eats up all the oxygen in its immediate area. Though none of

*1954 Argyle Avenue,
Hollywood, California.

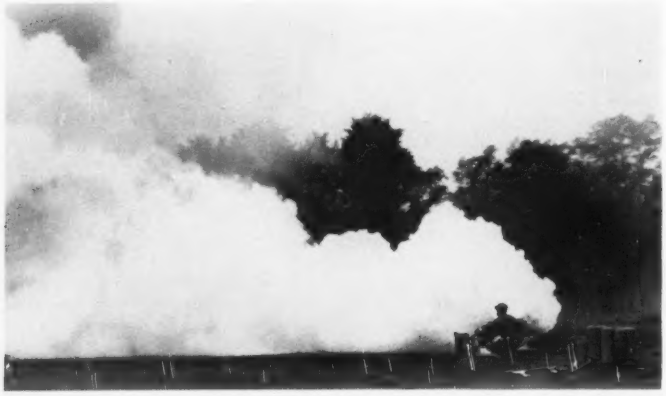
PHOSPHOROUS BOMB: White phosphorous bombs are used extensively in Korea and have been especially effective in knocking out enemy artillery concentrations. The phosphorous is difficult to remove from clothing or flesh. If it does not kill, the deep, painful burns are so hard to heal that the wounded may be out of action for months.

it may directly hit a person, humans often die from lack of oxygen before they can escape the circle of suffocation in a fortification. Others burn to death in its temperature of from 1500 to 2000 degrees Fahrenheit.

Napalm is commonly dropped in 100-gal. tanks from planes flying from 25 to 100 ft. above the ground. It is one of the weapons that will force Korean and Chinese Reds to rush out of their foxholes and hiding places into the open. When it falls in a nest of enemy foxholes, the Communists flee in terror and are then perfect targets for fighter pilots peering down the barrels of their machine guns.

Seldom is any napalm bomb a dud. Even if one fails to ignite after dropping, the pilot then explodes it with a burst of machine gun fire. Nor is it needful to make a direct hit on an enemy tank, train of cars, or road convoy. If the bomb hits anywhere near target, the objective may be destroyed. The fires these bombs start are often quite spectacular.

During one recent operation in Korea, a flight of 40 fighter planes dropped 80,000 gals. of the deadly jellied gasoline in the path of advancing Red troops. In addition, 27 towns were hit in the same action and 242 buildings were destroyed, eliminating much shelter for the Communists in sub-zero weather. All resistance in the area was knocked completely out.



ARTIFICIAL FOG: The creation of artificial fog is one of the most effective weapons used in modern warfare. Machines that make fog can manufacture it for days without interruption. Used as a screen, the fog can hide U. N. troops and their deployment from enemy observation.

White Phosphorous Munitions

Next to napalm, white phosphorous munitions are perhaps the most extensively used weapon of its type employed in the Korean campaign. These enemy-feared pyrotechnics are fired from cannon, mortars, small arms, thrown by hand, and shot in rockets. Pillars of white smoke rise when the phosphorous bursts upon enemy positions. Plumes of the chemical spurt in all directions. The stuff is difficult to brush off skin or clothing. Even when not fatal, the deep, painful burns are so hard to heal that the wounded may be out of action for months, if not totally unfitted for further duty. White phosphorous shells have the added advantage of pin-pointing foe positions, and of blinding enemy observation in the vicinity of bursts.

Smoke for smoke's sake, rather than the use of high explosives shells, is one of the startling phenomena of this war. There are many ways of making and projecting smoke. In shells, it is fired from cannon, mortars, and shoulder arms, smoke canisters being ejected from the base of the shells upon impact. Some is fired as rockets. Smoke pots can be fired singly or in chains, one pot automatically touching off the next in series. Pots are usually metal-covered cans containing up to 30 lbs. each of smoke-producing material. Some are manually fired; others by means of electric squibs or fuses. They spew smoke from 4 up to 40 minutes. Smoke pots that float in water have been developed. The Navy has employed them to cover mine-sweeping operations, landing craft approaching beaches, to cover flanks from enfilading fire, to protect ports, and to cover transport areas. The Army finds smoke from pots useful to cover demolition crews and has floated pots in streams to raise a curtain of smoke while bridges were being built or repaired. Smoke barrages can be made to advance as infantry attacks, keeping enemy gunfire inaccurate.

Smoke exists in every shade, from brilliant white through grays to dense black. It also exists militarily in four colors which are created by dyes: red,

green, yellow, and violet. Colored smoke is used to signal deployment and attack. Many a downed airman and lost soldier has been rescued through having his position spotted by either flares at night, or colored smoke by day, emitted from small pots that are held in the hand. These latter are much similar in looks and effect as the colored "smokes" many of us used as boys on the Fourth of July.

General Douglas MacArthur has called the Korean conflict a "war of maneuver." The same troops have fought on three fronts in a single day. Towns and terrain pass in and out of control with lightning rapidity.

Tiny Tim

A quickly fashioned rocket was the instrument that put a crimp in enemy tank depredations early in the Korean conflict. At one critical juncture, Communist tanks enjoyed an almost unlimited opportunity of maneuver before U. S. and other U. N. troops could get their mobile armor into play. The Navy scientists at Inyokern Test Center, California, working around the clock, designed the famous Tiny Tim, an 11.75-in. air-to-ground rocket. Tiny Tim was emergency-flown across the Pacific and was in action within two weeks after call. The huge rocket's shaped head gives it tremendous shocking power. It knocked out enemy tanks with ease and helped contain the front until American tanks and anti-tank guns could be assembled at the battle theater.

The Army has created particular fireworks for the destruction of secret documents and equipment that might otherwise fall into enemy hands. These are incendiary in nature. They are composed of thermite, a mixture of aluminum powder and iron oxide which, when ignited, burns with fierce heat. Such bombs have been used in Korea to burn steel safes and their classified contents, as well as ammunition, guns, and other supplies which, because of fluidity of battle, had to be temporarily abandoned.

TINY TIM: A huge rocket, known as Tiny Tim, has just been released from a U. S. Navy fighter plane. Terrific destroyers of tanks, these rockets have helped to turn the tide of many battles in the Korean War in favor of the U. N. forces.

U. S. MARINES: As preparations are made to advance against the Communist foe, a group of United States Marines carefully observe the effect of pyrotechnic-type shells and bombs as they are exploded upon enemy concentrations.

More Smoke

Tongue-twisting names identify some smoke. A white kind is called hexachloroethane. Sulphur trioxide and chlorosulfonic acid is a liquid which, upon exposure to air, forms a dense white cloud. Titanium tetrachloride, a white cloudy smoke, is a throat irritant as well as an effective screen maker.

Smoke has become so important in modern warfare that the U. S. Army has designed and built a mobile smoke-manufacturing machine that looks very much like the olden-day, coal-stoked fire engine.

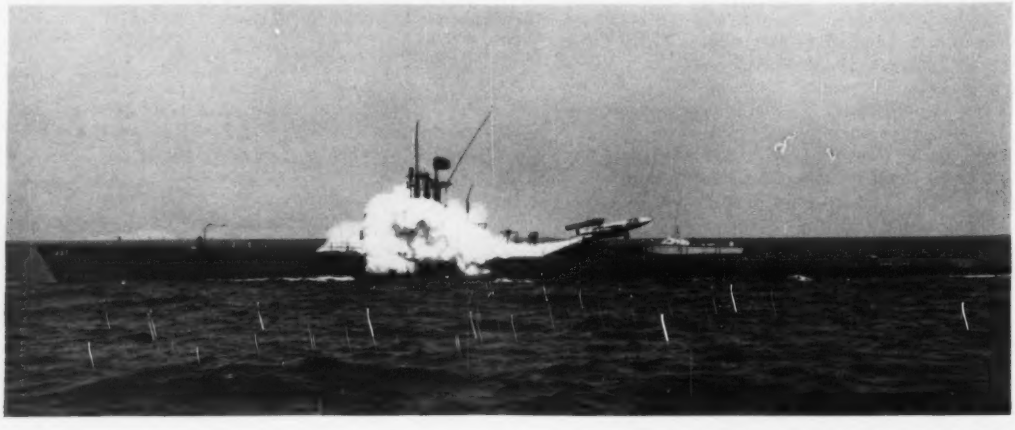
These 4-wheel generators emit mountains of misty smoke even while on the move, and can continue for days without cease. Their product can be used on foe or for friend. When the wind is right they can lay down thick "pea soupers" of whitish fog that renders enemy troop movements precarious if not impossible. Another kind of fog, nonnoxious and not an eye irritant, can wend through thick forests or over nearly any kind of relatively level terrain, and make friendly silhouettes invisible to the enemy while military preparations go on without interruption. The portable smoke generators

are of two types: the self-propelled, and those which require a tractor, tank, or jeep for motivation.

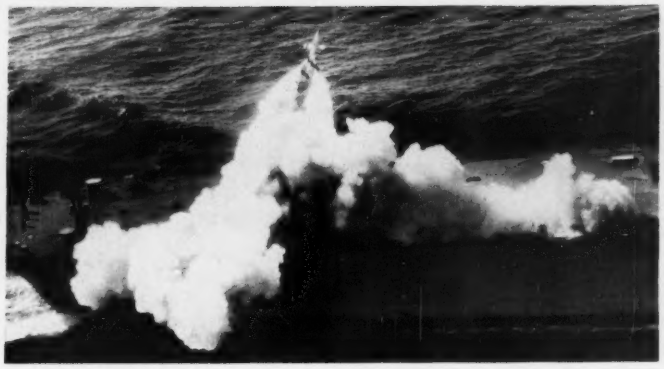
For the most part, smoke is laid down in clear-cut patterns. Many times in the Korean War, U. N. paratroopers have been dropped back of smoke curtains without casualty from enemy fire. Vertical curtains may be laid from the ground, if the terrain is in friendly hands, or from the air. If from the air, each following plane flies about 100 ft. above the other and so on, laying successive tiers of smoke. By laying smoke roofs over curtain areas, the contained arenas become invisible not only from the ground but from enemy air observation.

Weather is a determining factor in smoke application. It can inform when smoke is to be used and the right types as well as the manner of use. Greater saturation is called for in a 15-mile wind than a 5-mile one. Screens, for instance, are seldom called for when wind velocity exceeds 15 m.p.h. Warm weather with fairly high humidity is usually welcomed. It is then that smoke is most effective under most conditions, provided wind velocities are low.

NAVY'S VIKING: The U. S. Navy's Viking rocket just before it was launched at White Sands, New Mexico. This type of pyrotechnics is used to explore the region above the surface of the earth for research data.



FROM A SUBMARINE: An air missile is fired from a submarine off Point Mugu, California, where the U. S. Navy has a giant test center for carrying on experiments with "Flash Gordonish" types of munitions.



THE LARK: This guided missile, known as the Lark, starts with a swoosh from the deck of USS Norton Sound. Such missiles use many forms of chemicals produced by the manufacturers of explosives in the United States.

Meteorologists are vital functionaries in the new scheme of battle pyrotechnics. Smoke can easily react adversely and aid the enemy. Accurate weather forecasts are a must, and meteorologists are always consulted before such operations are undertaken.

Rockets, Flares, and Star Shells

Rockets, a long-known form of pyrotechnics, helped pin down the enemy during the Inchon invasion. Fired from naval ships, this display of firepower is not only one of the most impressive to watch, but one of the most effective ever devised to protect troops going in on beachheads.

Newsreels are filled with pictures of airplanes strafing the Korean Reds with rocket bursts. Fitted with shaped heads (designs for exploiting specific tasks), these fireworks have wrought fearful destruction to enemy personnel, tanks, installations, and structures. Even one-man bazookas can knock out any North Korean or Red Chinese tank from any angle.

During the first phase of the Korean War, North Korean Reds were able to penetrate U. N. positions under the cloak of night. But pyrotechnics have shown us how to blunt those sneak attacks and throw the enemy back on his haunches. Flares and star shells show the way. Used to light up enemy ranks and throw attackers into sharp outline, the foe is now cut down with mortar, machine gun, and small arms fire before attaining his objective.

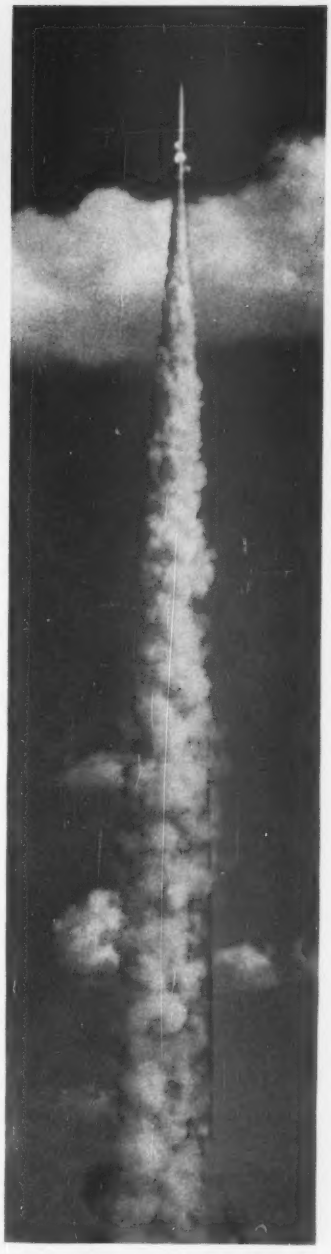
Demolition

The Army has squads of technicians skilled in the art of demolition. Several kinds of explosives are employed, depending on the character of destruction and the material to be blasted out of the way. Probably, the most widely used is C-3. It is comparatively safe and is resistant to moisture. When cratering is the object ammonium nitrate is usually specified on account of its fast expansion. Black powder in cans and waterproof bags, tetrytol, and the plastic explosives C-2 and C-3 are employed in Korea for various types of demolition, including bridges, warehouses, railroad tracks, roads, docks, towers, and buildings. Blasting machines as well as fuse are used in ignition.

"In the overall, pyrotechnics have played a magnificent role in Korea," summed up an Army colonel.

"By deft employment, two United Nation troops have been able to pin down eight of the enemy. Military pyrotechnics are one of the great contributions in this war. These weapons are taking heavier toll during current operations than many conventional weapons."

The Korean War has been a bloody experimental field for new weapons and the improvement of old ones. And although they may not be specifically mentioned, it may be said that Uncle Sam's arsenal is developing still more effective "fireworks," should occasion demand their going into battle for us at some future time.



NAVY'S AEROBEE: A U. S. Navy sky-searcher, called the Aerobee, takes off into the upper stratosphere with all the flavor of a 4th of July celebration.

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For record-breaking performance . . . for ease of operation, you can't top a McCarthy Vertical Drill. Recently, on one difficult job, workers using McCarthy equipment drilled an 8-inch hole 100 feet deep in only 40 minutes! The derrick is raised and lowered by hydraulic power . . . finger tip controlled . . . and a 60 H. P. gasoline motor is part of the standard equipment.

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Lee Sonic Ear-Valv

A SMALL plastic and metal valve, seated in springs, automatically damps out vibrations above the average human tolerance.

The Lee Sonic Ear-Valv, a tiny ear valve that reduces the impact of sound waves upon eardrums, may become a boon to miners, quarrymen, and others who work near loud noises.

The device is not an ear plug but a small plastic and metal valve seated in springs that automatically damps out vibrations above the average human tolerance. It fits the ear canal almost unnoticed.

The sonic filter eliminates the harmful effect of sudden, blast-type noises; at the same time it leaves the ear canal open and permits the passage of normal voice-level sounds. It is said to eliminate the forces caused by the vacuum that follows an explosion.

The filter is being widely used at pistol and rifle ranges, rocket test stations, machine gun pits, missile-launching sites, and skeet clubs. Tests made by United States armed forces indicate that it may become of great aid to G.I.'s in combat warfare, because of its protection to the eardrum against all armament firings and explosions.

The valve is fully automatic, requires no adjustment, and has no dependent parts such as wires or batteries. Mills, shipyards, and factories are finding that the use of the device improves the quality and amount of work, it is claimed. It relieves the effect of changes in air pressure that disturb some air travelers and pilots.

The Lee Sonic Ear-Valv is ready for distribution by the manufacturer, Sigma Sales Corporation, 1491 Vine Street, Hollywood 28, California. Further information may be obtained by writing to the manufacturer.

SAFETY AWARDS

(Continued from page 81)

for the Sentinels of Safety trophies shall be submitted for examination. This provision of the rules is additional assurance to the competing companies of the quality of treatment of the records submitted by them to the Bureau of Mines. Members of the Committee of Award to whom the records of the leading companies in the 1950 safety contest were submitted include: Julian D. Conover, secretary, American Mining Congress; William Green, president, American Federation of Labor; J. D. Battle, executive secretary, National Coal Association; A. T. Goldbeck, engineering director, National Crushed Stone Association; A. J. R. Curtis, assistant to general manager, Portland Cement Association; Ned H. Dearborn, president, National Safety Council; and Dan Harrington, consulting engineer.

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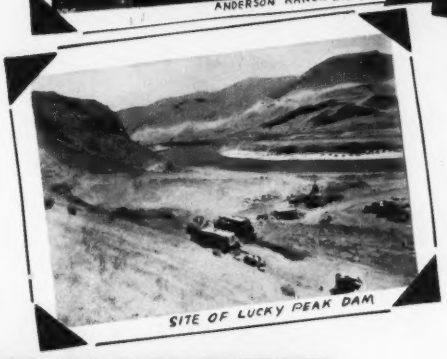

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Helps Plug the Gaps . . . as America Still Moves

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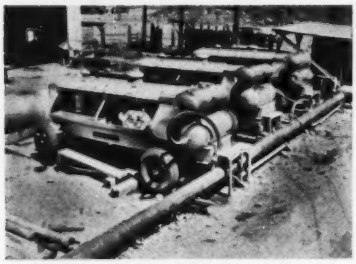
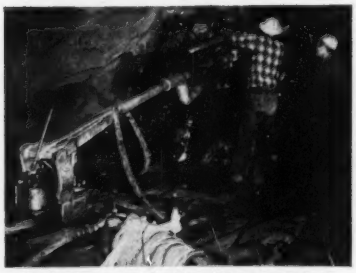


Three Gardner-Denver WH-500D Portable Compressors supplying compressed air for drill work on diversion tunnel on the Lucky Peak Dam project. Two Gardner-Denver WB Vertical Water-Cooled Stationary Compressors also deliver into the same air line.



Gardner-Denver JB-11 Hydraulic Boom—with Gardner-Denver Drifter—mounted on jumbo in 30' diameter Lucky Peak diversion tunnel. The Gardner-Denver Air Hoist in the foreground is used to lift equipment from tunnel floor to top of the jumbo.

This series of dams on the Boise River will help supply America's growing West with more electricity to power its industry—more water to irrigate its farmland.

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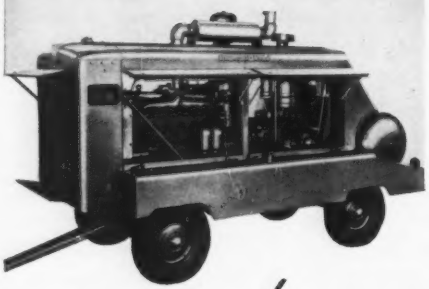

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- Dual actuator motor control valves located at end of boom arm permit operation from either side of boom.
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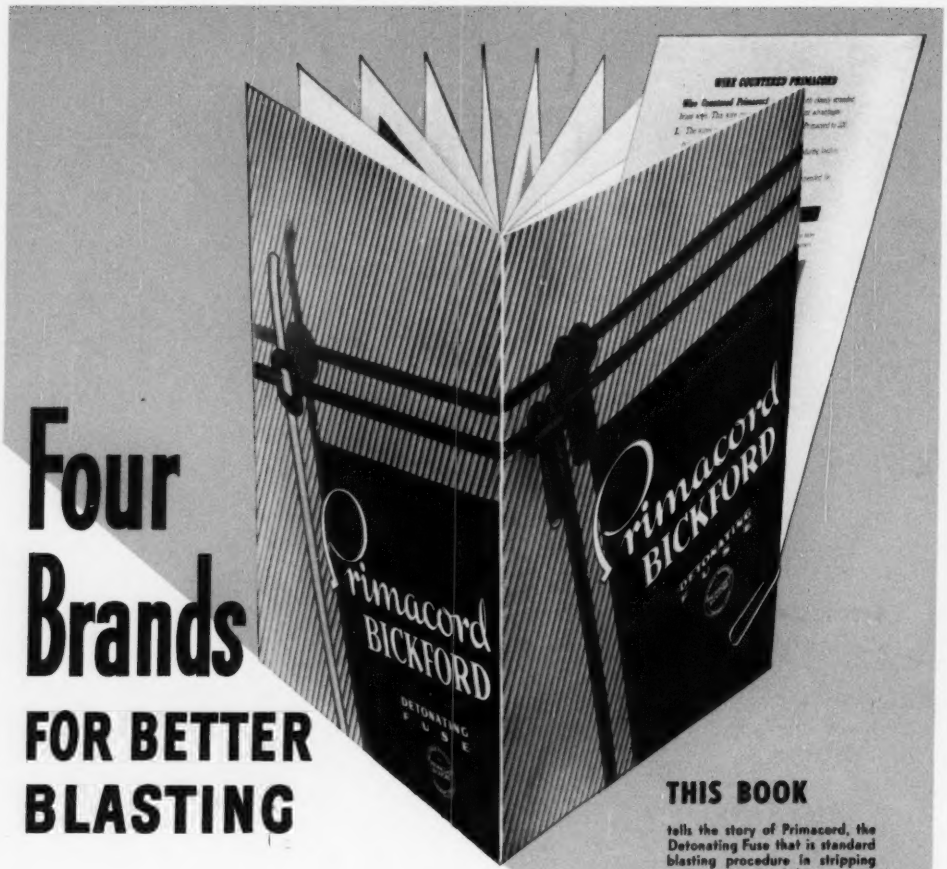

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